TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE
IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XIII, No. 6. JUNE, 1936. PRICE 6d.

CONTENTS.

	PAGE.
Imperial Agricultural Research	141
Soil Crumb	143
Review	145
A variety test in sugar-cane	146
Root disease of the lime in Montserrat...	147
The College Sugar Factory—Crop 1936 ...	148
Note on the Vegetative Propagation of Derris	149
Stock Rearing in the Tropics	151
The Biology and Control of Termites ...	153
Air-Conditioning in the Tropics	154
Observations on the early larval mortality of certain species of *Diatraea* (Lepid., Pyralidae), under cane field conditions in Trinidad	155
Cotton Notes	160
Trinidad Mammals	161
Sugar Notes	166
Chemical Notes	167
Trend of the Markets	168

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C.3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing members of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development.

IMPERIAL AGRICULTURAL RESEARCH.

NINE years have elapsed since the Imperial Agricultural Research Conference was held in London. So many changes have occurred in the organisation of research throughout the Empire and so many new developments have taken place that the time is ripe for taking stock of the progress made and for a thorough survey of the machinery in order to make it still more effective. The 1927 Conference marked the first occasion on which research workers assembled from all parts of the Empire in an effort to survey and organise its scientific agricultural resources. Questions of administration relating to staffs and institutions were its chief concern. Much attention was devoted to proposals for creating a chain of research stations, for setting up Imperial Agricultural Bureaux and for the recruitment, training and interchange of workers. Various agricultural problems confronting different parts of the Empire were considered by several groups of specialists. Considerable improvement resulted in the then-existing machinery for co-operative research throughout the Empire and a number of what may now be regarded as indispensable institutions have been created to cope with the ever increasing problems presented by Imperial agriculture. At the conclusion of the Conference it was recommended that a similar meeting should be held in Australia in 1932, but for reasons of economy the project had unfortunately to be abandoned. In view of the numerous advantages which would undoubtedly be derived from holding another such conference it is suggested that steps should be taken as early as possible to call another Imperial Agricultural Research Conference for next year. 1937 should indeed afford an admirable opportunity for such a meeting since so many events of Imperial significance are likely to take place in connection with His Majesty King Edward VIII's accession to the throne.

One of the chief outcomes of the 1927 Conference was the establishment of eight Imperial Agricultural Bureaux dealing respectively with soil science, animal nutrition, animal health, animal genetics, animal parasitology, plant genetics (crops and herbage plants being considered separately) and fruit production. These Bureaux were set up in 1929 under the directorships of the research

institutes in Great Britain at which they were located. Controlled by an Executive Council which, in October, 1933 also assumed control of the Imperial Institutes of Entomology and Mycology, the Bureaux are financed from a common fund to which all Empire countries represented on the Council contribute a share. The main function of each is to act as a clearing house of information in that branch of agricultural science with which it is concerned and to promote direct contact with research workers overseas. Research information has been collected from all parts of the world and particularly helpful summaries have been disseminated to every interested worker in the Empire since their inception. The Bureaux undertake no research work but persons working on similar problems in different countries are put into touch with each other, thereby aiding co-operation. The Bureaux may be regarded as a new type of Imperial organisation which has rendered invaluable services to agricultural research workers throughout the Empire. As such, a review of their respective activities and a discussion of their future policy, especially in regard to initiating further facilities for co-operative action in regard to the collection and dissemination of research information would be of advantage. The question of creating additional Bureaux to cover other fields such as agricultural economics should also be considered.

In 1927 considerable discussion took place on the recruitment, training and interchange of research workers. At that time the Colonial Office Agricultural Scholarships scheme had only just been launched and was, therefore, still in the experimental stage. This scheme has not only proved successful but has also done a great deal towards raising the efficiency and prestige of the Colonial Agricultural Service. The scholarship candidates generally spend their first year of training in Great Britain, at Cambridge University, and their second, in Trinidad, at the Imperial College of Tropical Agriculture. Since the inception of the scheme the system of training has been modified to meet the requirements of the Service, and several Directors of Agriculture have expressed their appreciation in no uncertain terms of the value of this training to agricultural officers on first appointment. An exchange of views between those responsible for framing the courses of instruction and Directors of Agriculture should prove of great value. The opinions of ex-students who are now in the Service would be especially helpful. From 1925 to 1935 inclusive no fewer than 170 scholarships were awarded. The annual award of scholarships between 1925 and 1932 varied from 14 to 24 but as a result of the economic depression and heavy reductions in the number of vacant posts, it was decided that not more than ten scholarships should be awarded annually from 1933 to 1937. It is unfortunate that such reductions should have been found necessary but it is hoped that as conditions improve a greater number of studentships will once again be awarded. In addition to the scholarships scheme, greater advantage might possibly be taken of the facilities which are being provided at the College in the form of refresher courses. These courses have been very popular with senior officers who were able to attend them, and ways and means for extending the practice of sending such officers to Trinidad for training of this kind should be considered.

There is also the question of the interchange of research officers. We have already dealt at length with this subject (1). There can be no doubt as to the benefits, both from the research and teaching aspects which would be derived from a more general development of this system We urge therefore, that particular attention be paid to the manner in which a regular scheme for the interchange of suitably qualified officers might be carried out.

Although the Imperial College of Tropical Agriculture and the Amani Research Institute have developed considerably since 1927, no progress has been made with the proposals for creating other research stations of this type in the Colonial Empire. On the other hand, there have been considerable developments in a slightly different direction as the policy, during the past few years, appears to have tended more towards the establishment of research stations dealing with specific crops. As examples, the Cotton Research Station in Trinidad and the Coffee Research Station in Tanganyika may be quoted. Both these stations differ considerably in constitution from the central research stations envisaged by the Research Special Sub-committee of the 1926 Imperial Conference in which the ultimate idea was to create " a chain of research stations linked together by a common interest in related problems and providing a fertile field for team work and the interchange of ideas and men throughout the Empire ". With regard to the central research stations, a Colonial Office Committee under Lord Lovat's Chairmanship recommended that no other links in the chain should be forged until the Amani Research Institute had been thoroughly established. Amani has now reached this stage and the time appears opportune for a reconsideration of the whole of this matter in relation to the new developments referred to above.

If a Second Imperial Agricultural Research Conference is to take place it should be held primarily with the object of reviewing the working of the machinery for research all over the Empire in such administrative and semi-administrative matters as were discussed at the 1927 Conference. The completeness and efficiency of that machinery are of great importance to the whole of the Empire and deserve once again to be thoroughly surveyed and overhauled. Consideration of various agricultural problems might, as before,

(1) *Tropical Agriculture*, XI, No. 12, 301.

be delegated to groups of specialists but it would also be of advantage to discuss subjects of general interest during the plenary sessions. In particular, we would mention the need for considering the question of ways and means for translating research into practice. The Empire has now an admirable organisation for the collection and dissemination of information amongst all kinds of research workers but such research is of little value unless it can be translated into agricultural practice. The methods whereby this can be accomplished, particularly amongst the small peasant proprietors in the tropics, should form a prominent part of the discussions at the Conference.

We have already drawn attention (2) to the need for calling an interim conference of delegates from the tropical colonies so that tropical agricultural matters receive a due amount of attention, and we hope that arrangements will be made for this to take place immediately prior to the main Conference.

(2) *Tropical Agriculture*, V, No. 2, 21.

SOIL CRUMB*.

THE most striking physical attribute of many fertile soils is their natural tendency to the formation of a crumb structure. This tendency is utilised by the farmer or planter in the production of a good tilth in his cultivations. Soil-tilth greatly contributes to the development of suitable water and air conditions which are of primary importance in the successful growth of the majority of crop plants.

Soil crumb cannot develop in soils entirely devoid of colloidal matter. Pure sand never forms crumb ; its particles remain separated when the sand is dried, and settle into a closely-packed mass when it is wetted. At the other extreme, highly colloidal clays may only form crumb when certain conditions are realised. In the absence of these necessary conditions, clay soils merely crack into large lumps when dried, or " run together " into an impervious mass when wetted. The most suitable kind of soil for crumb formation is probably one containing a fair amount of colloidal matter in a suitable condition, together with a dilutant consisting of an assortment of grains of silt and sand of various sizes. The colloidal matter may be either inorganic (clay substance) or organic (humus). It possesses the ability of binding together the individual soil particles into aggregates and the aggregates into crumbs. In this way the soil assumes a characteristic and well-known structure, usually associated with high fertility.

It is imperative that the crumb structure developed in a soil by natural processes or by suitable cultivation should be *stable*. If the crumb be unstable, the soil tends readily to break down into its component particles, which then may be easily washed away by running water or blown about by wind. Such unstable soils suffer severe erosion, and their drifting frequently becomes a serious menace.

Soils possessing no crumb structure at all exhibit a continuous pore-space distribution, which permits either air or water to move more or less freely through them, though air *and* water cannot each move freely if both occur together. When a stable crumb structure is developed, however, pore-space distribution becomes discontinuous. Although the pore-spaces within the individual crumbs may be continuous, cracks and spaces occur between the crumbs, so that there is sufficient room for the free circulation of both air and water around the crumbs. The finer pores within the crumbs may hold an appreciable amount of water which is available to plants even under fairly dry conditions. The larger cracks and spaces allow surplus water rapidly to drain away, and at the same time, they allow air and carbon dioxide to circulate freely, maintaining a high degree of aeration within the soil. The colloidal matter which binds the soil particles into crumbs also possesses the property of absorbing air as it dries. This air is liberated again when the colloidal matter is wetted, but it becomes entrapped in the form of minute bubbles. Hence, during temporary water logging, the colloidal matter provides a source of oxygen for plant roots, thus preventing asphyxiation.

The mechanism of crumb formation, and the precise factors which confer stability on the crumb are not yet completely understood, although they are being actively investigated in certain research institutes, notably the Rothamsted Experimental Station in England. It is known that the primary requisite for crumb formation is that the soil should first be wet, and that the water in it should then be removed at a certain rate. Water removal may be effected either by direct drying or by freezing. Frost is perhaps the most effective natural known agent for producing crumb structure and a good soil-tilth. In northern countries, clay lands are roughly ploughed in the late autumn, so that as large a surface as possible is exposed to the action of frost when winter comes. In countries where no winter is experienced, the alternative process of direct drying is utilised for producing a tilth. The land is ploughed into large clods during the early part of the dry season, and these are allowed to

* *Acknowledgment.*—The subject matter of this article has been taken mainly from the recent writings of Dr. E. W. Russell of the Rothamsted Experimental Station, particularly " A Physical Description of Soil Tilth ", *Sands, Clays and Minerals*, April 1936, Vol. II, No. 4, pp. 57-63.

dry out during the following months. When the first rains come, the land is cultivated, and the shattered lumps then break down into crumbs. The mechanism of this action is probably attributable to the liberation of entrapped air during the wetting process. The air forms holes and channels within the clods, which consequently become mechanically weaker and shatter readily under the action of the plough and the harrow.

A third method is often practised in countries where frost is unknown, and particularly if the soil lacks organic matter. It consists in the growing of heavy grass crops or vigorous leguminous plants, whose rootlets hold the soil particles together, and thus impart a crumb structure to the soil. The incorporation of bulky organic matter into the soil furnishes a supply of colloidal matter, which will confer a crumb-forming ability when the soil lacks colloidal clay.

The particular size of crumb most suited to the crop depends partly on climatic conditions. In humid climates, the chief need is an adequate air supply to the roots, so that an open structure is best, and the crumbs should therefore be of relatively large size. In arid regions, on the other hand, water is usually the limiting factor, so that a close compact structure is best, and the soil should have a fine crumb structure conducive to water conservation. For the best results, the size of the soil crumbs should range from about 0.5 to 3.0 millimetre, depending on the air and moisture requirements. Smaller crumbs block the air channels without increasing the water-retaining capacity, whilst larger crumbs enhance the rate of evaporation of water, causing plants to die from desiccation.

Factors affecting Crumb Formation and Crumb Stability.

The proportionate amount of colloidal matter in the soil requisite for the suitable development of a crumb structure is not known with certainty, although the effects of either too little or too much colloidal matter are well understood. The smaller the colloidal content the larger the pore spaces and the weaker the crumbs. The crumbs dry out more readily, but they yield only small amounts of air when rewetted. Hence plants are liable to suffer both from water-logging and from drought. The greater the colloid content, the more difficult it is to obtain a good structure. The pores within the crumbs may be too minute to enable plant roots to remove water from them, in spite of the fact that the clay component of the crumbs contains large amounts of water which is tightly held. Hence plants are liable to suffer from lack of water when the clay content is high, even though the total amount of water present in the soil is relatively great.

The effect of organic colloidal matter (humus) so far as is known, is similar in most respects to that of colloidal clay. Its main difference probably lies in its effect on crumb size, although the magnitude of this effect has not yet been ascertained. Another important property which organic colloidal matter confers on soil in greater degree than inorganic colloidal clay is to increase the pore space within the crumbs, and thus to improve materially their water-retaining capacity and their ability to supply water at a rapid rate to growing plants. Organic colloid also in some way reduces stickiness and improves a soil's workability, but little is known about the mechanism of these effects. Soils rich in organic matter are never so sticky, and are very much more spongy and springy, than soils containing corresponding amounts of colloidal clay. Their humus component probably absorbs more air, and it certainly does not give it up again with the same facility as clay colloid. Highly organic soils are therefore more difficult to wet than heavy clay soils.

The *stability* of soil crumb is of two sorts, namely, mechanical stability and water stability. The former enables the crumb to withstand the action of beating grain or gusty wind; the latter enables it to maintain its structure when thoroughly wetted. Both types of stability appear to depend on the nature, composition and chemical attributes of the colloidal matter that holds the soil particles together. Recent research has established the fact that the seat of the important binding forces is the *surface* of the colloidal matter. Such surfaces are chemically very active ; they are capable of combining with or "adsorbing" entitities such as water molecules and ions of various sorts, particularly basic ions, for example, calcium, magnesium, potassium, sodium and hydrogen ions. The ability of colloidal material to combine with ions and to exchange them for other ions confers upon it what is known as " base exchange capacity". In order for soil crumbs to be formed, the base exchange capacity of the soil should exceed 20 units (milligram equivalents per 100 grams of soil). The measurement of base exchange capacity is now a routine procedure in soils laboratories, so that the soil chemist can readily determine whether or no any given soil is likely to form crumbs easily, merely by determining its total exchangeable base content.

It is quite likely that basic ions bind colloidal surfaces together through bridges of water molecules. The positively-charged (hydrogen) end of the water molecule (H·OH) is attracted to the negatively-charged colloidal surface, and the negatively-charged (OH) end is attracted to the positively-charged basic ion.

The conditions that decide the size of soil crumbs are not yet known, but evidently one factor is the rate of drying. The faster water is removed, the smaller the crumb. Another factor appears to be salt content. Soils having large contents of salts (such as sodium chloride) develop only small crumbs. Such conditions may characteristically occur in nature ; for example, arid-land soils are generally subject to rapid drying, and common

salt is a usual component in them, so that the natural soil structure in this case is one distinguished by small crumbs. In soil survey studies observations of the natural size and shape of the crumbs is frequently employed as evidence of the conditions under which soils have been formed.

The proportionate amount of the different exchangeable ions associated with the colloidal matter in a soil seems mainly to decide the *water stability* of the crumbs. If more than 20 to 30 per cent. of the exchangeable ions of a soil are sodium-ions, the soil will usually form crumbs that are markedly unstable when wetted. Such "sodium-clay" soils may produce a good tilth when properly cultivated in favourable weather, but the whole structure rapidly and completely disappears when the first soaking rains arrive. The surface may subsequently solidify into a hard cake after drying conditions have again set in, and plant roots may be injured so that the crop is irreparably damaged. Nevertheless, soils rich in exchangeable sodium-ion, but containing at the same time abundant free sodium salts may appear to possess a stable crumb structure, but this is lost when the excess of salts is washed out or leached away by irrigation with pure water.

On the other hand, soils containing a large proportion of exchangeable calcium-ions usually produce crumbs that are very stable in the presence of water. This fact may partly explain the beneficial effect of thorough liming on the physical properties of acidic clay soils. Much fuller information is needed concerning the water and ionic conditions prevailing in the neighbourhood of colloidal surfaces before the causes of water-stability of soil crumb can be fully understood. The different ions operate to different extents, but sometimes in opposite directions. Thus sodium-ion and calcium-ion appear to be antagonistic in their effects on crumb stability, whilst magnesium-ion seems to resemble sodium-ion rather than calcium-ion, and potassium-ion and hydrogen-ion resemble calcium-ion in their ability to confer a fair degree of crumb stability on a soil containing a sufficient amount of colloidal matter.

In farming practice, mechanical cultivation operates in two chief ways. If the soil possesses a good crumb structure, cultivation improves it by developing tilth which directly benefits the crop by improving the moisture and air conditions. If the soil possesses no crumb structure, and has bad tilth, cultivation puts it into the best condition for weathering agents to act on it. Cultivation implements should be used in such a way that a stable tilth is produced in a previously structureless soil, or an already existing tilth is not destroyed, and at such a time that the greatest benefit to the soil's structure is realised. Successful tillage thus demands knowledge and experience on the part of the cultivator, both with regard to the correct kind of implement to use, and the right time to use it. Thus, a good stable tilth in a heavy clay soil may be completely spoiled by ploughing with a steel mould-board plough when the soil is too wet. Such a soil should either be allowed to dry before ploughing, or a wooden mould-board plough should be employed. Liming has been proved at Rothamsted to reduce the force needed to draw implements through the soil. This effect may be explained by the more stable crumb structure which the lime confers on the soil. Heavy dressings of organic manure produce similar results, whilst cropping with green manures probably aids crumb formation through the binding effects of tiny rootlets.

The formation of a satisfactory explanation of the various stages in crumb production and the elaboration of means of measuring the various factors involved seem now to be within reach. Before long it should be possible to design field experiments to test the main conclusions, and thus further to develop the practice of field husbandry on precise scientific lines.

F. HARDY.

REVIEW.

SANDS, CLAYS AND MINERALS.

A British Magazine devoted to Economic Minerals, published by A. L. Curtis, Chatteris, England.

This interesting magazine is issued about twice or three times yearly. The first number appeared in April, 1932. The current issue (April, 1936) contains numerous authoritative articles of considerable general importance. Among them are papers on Rotary Drilling Fluids, which gives an account of some modern methods used in oil boring, on Mineral Resources of East Africa and of Rhodesia, on the Uses of Industrial Diamonds, on Mining in the Gold Coast Colony, and on the Manipulation and Applications of Radium. Other specialised articles describe the use of the spectrograph in industry, the employment of the nephelometer in the investigation of minerals, the chemical analytical methods applied to the identification of earthy pigments, and the apparatus employed for classifying sands and for testing moulding sand.

Perhaps the most interesting article of all as far as the agriculturist is concerned is one by Dr. E. W. Russell of the Rothamsted Experimental Station, England, entitled "A Physical Description of Soil Tilth". Dr. Russell is the son of the Director of the Rothamsted Station. His clear explanation of the factors which control the formation of soil crumb is based mainly on the results of his own investigations which have gone far to elucidate one of the most perplexing problems of soil physics. A review of this work and its bearing on soil cultivation is presented in this issue of *Tropical Agriculture*, pp. 143-145, and has been taken mainly from the article above mentioned.

F. H.

A VARIETY TEST IN SUGAR-CANE.

By R. Cecil Wood, M.A.
Professor of Agriculture, Imperial College of Tropical Agriculture.

Another crop has been taken from the variety test of sugar cane referred to in previous numbers of this Journal* making the fourth ratoon, or five crops in all. The yields have shown a marked improvement all round, and are really remarkable, when the circumstances are taken into account. The yields of cane only are recorded this year, as it was not possible to have the crop crushed at the College Factory, but the relative quality of the different kinds may be assumed to be similar to those already recorded.

The yields of cane for the five crops are given in Table I.

The canes have received manure as follows:—(All figures per acre).

1930-31.—Seven tons limestone in April. A very heavy crop of sunn hemp was ploughed in in August, and in September 12 tons of pen manure. Canes planted in October.

1931-32.—

1932-33.—One cwt. Sulphate of Ammonia (approximately).

1933-34.—One cwt. Sulphate of Ammonia.

1934-35.—Amm. Sulphate 3 cwt.; Muriate Potash, 1 cwt.; Superphosphate, 1 cwt.

1935-36.—Amm. Sulphate, 3 cwt.

Table I.

Variety.	Tons cane per acre.					Total for five Crops.	
	Plant.	1st	2nd	3rd	4th	Tons cane.	% Uba.
P.O.J. 2878 ..	63	30	34	30	41	198	146
Co. 213	57	34	26	23	30	170	125
P.O.J. 36 ..	33	26	22	21	27	129	95
M. 36 (2 plots only)	*48*	*32*	*25*	*22*	*29*	*156*	*115*
P.O.J. 213 ..	23	20	17	17	21	98	72
Uba	**37**	**26**	**19**	**23**	**31**	**136**	**100**
Co. 281 (2 plots only)	*47*	*31*	*24*	*15*	*21*	*138*	*101*
P.O.J. 234 ..	30	23	20	14	19	106	78
P.O.J. 826 ..	33	20	13	7	16	89	65

Significant differences between totals: 4.8 tons per acre.

If it is accepted that the *relative* quality of the varieties based on analyses of the four previous crops, is likely to continue much the same, an estimate of the yield of sugar per acre for the five crops works out as follows:—(Table II).

Table II.

Variety.	Tons of cane to one ton sugar. Mean of four crops.	Total tons sugar per acre for five crops.	Per cent. on Uba.
P.O.J. 2878 ..	10.1	19.6	169
Co. 213 ..	11.5	14.8	127
P.O.J. 36 ..	10.8	11.9	102
M. 36 ..	*11.6*	*13.45*	*116*
P.O.J. 213 ..	9.0	10.9	94
Uba ..	**11.7**	**11.6**	**100**
Co. 281 ..	*11.5*	*12.0*	*03*
P.O.J. 234 ..	9.4	11.2	97
P.O.J. 826 ..	9.5	9.3	82

The yields of Uba are shown in thick type because this cane is well known in Trinidad, and may be taken as a standard thin cane. The figures speak for themselves, and need little explanation. The Java cane P.O.J. 2878 continues to show itself a heavy cropper, and completely dispels the idea that it is a poor ratooner. It is in fact an extraordinarily good field cane, but unfortunately, until a method of dealing with it in the Factory has been evolved, it does not seem likely that it will be grown over a very wide area, owing to the great difficulty experienced in clarifying the juice. It is such a heavy cropper that it should be worth while giving this matter some attention. Of the others, there is not much to say: P.O.J. 36 has dropped considerably with reference to Uba, and so has P.O.J. 213. It rather looks as if the hardy Uba was lasting the course better, though Co 213 is still well ahead.

The experiment is being continued.

* Vols. IX, p. 290; X, p. 188; XI, p. 201; XIII, p. 35.

ROOT DISEASE OF THE LIME IN MONTSERRAT.

By R. E. D. Baker.
(*Lecturer in Mycology, Imperial College of Tropical Agriculture.*)

Introduction.

Since its inception in the middle of the last century, the lime industry in Montserrat has suffered many vicissitudes. Hurricanes in 1899, 1924 and 1928 have wrought havoc in the plantations, and serious droughts have taken their toll of the trees. After the 1928 hurricane many of the lime fields were not replanted, but Sea Island cotton is being grown round the surviving trees. The area under limes is thus considerably smaller than it has been in the past, and if the scattered lime trees in the cotton fields are not taken into account, there is, at present, less than three hundred acres under limes in the island. There is probably little land left really suitable for lime cultivation. Moreover, many of the old fields which are now in cotton have suffered so much from soil erosion that it is unlikely they could ever be re-established in limes.

The existing lime fields are situated on the lower slopes of St. George's and Garibaldi Hills and in the bottoms of certain of the gullies or 'ghauts' as they are known locally. The soil, volcanic in origin, is mainly a light sandy loam containing many stones and boulders. In general, the subsoil appears to be heavier.

The rainfall of Montserrat is low compared with that of most other West Indian islands, a factor which, when coupled with the light porous soil, makes the threat of drought a serious one. The rainfall, though light, is well distributed throughout the year, there being normally a fall of from three to four inches a month throughout the dry season. This dry season rainfall is of importance to the cotton crop which is planted in February or March, two of the driest months of the year, in order as far as possible to avoid losses from the pink boll worm. It is also an important factor in the cultivation of the lime, since a severe dry season on such light soil would probably be fatal to the trees. The water supply of the soil is apparently near the low limit for citrus cultivation under non-irrigated conditions and will not support any of the larger citrus fruits.

Protection from wind is a first essential for lime cultivation under these dry conditions. This is achieved either by planting the trees in sheltered situations, such as the bottoms of the ghauts, or by planting windbreaks. The 'Bread and Cheese,' *Pithecolobium unguis-cati*, makes a good hedge and is giving the best results at present. Other trees such as the White Cedar, Mango and Pois-doux are used with varying success. Many fields, however, exhibit the effects of exposure to the wind and more attention should be paid to the windbreaks. In establishing a young field of limes it is advisable to get the windbreaks well grown before planting the limes. Cotton may be grown in the field while the windbreaks are being established and the apparent loss of time will be amply repaid by the improved growth of the young trees when they are planted.

Diseases and Pests.

In the past the trees have suffered severely from diseases and pests, and 'Dieback' has been the subject of much investigation. It has been shown that both *Diplodia* dieback and attack by scale insects are largely brought about by exposure to wind, and that more careful attention to windbreaks has resulted in a diminution of the trouble. The hurricane survivors in the cotton fields, being fully exposed to the wind, often suffer severely in this way. The disease now under investigation although exhibiting dieback symptoms is quite distinct from the *Diplodia* type of dieback. In addition to windbreaks the more general use of mulch in the dry season would undoubtedly be beneficial in the prevention of dieback.

Red Root Disease, *Sphaerostilbe repens*, is present in the island, but up to the present has caused no serious losses; environmental conditions probably being too dry for its active development.

Wither-tip, *Gloeosporium limetticolum*, one of the most serious diseases of the lime, made its appearance a few years ago on the windward side of the island and has since spread to all lime-growing areas. Possibly again, owing to the dry climate, it does not appear to be as serious in Montserrat as in other West Indian islands.

Undoubtedly the most serious of the diseases and pests of the lime in the island at present are the *Diaprepes* root-borers, which are causing considerable damage to the plantations. Weevils of the genus *Diaprepes* have been known in Montserrat and other West Indian islands for many years and are possibly indigenous to them. They are well known cane pests and have been mentioned several times as a cause of damage both to the foliage and to the roots of citrus trees. There are at least two species in Montserrat, the adults of both feeding and laying their eggs on the foliage while the larvae eat the bark of the roots. The present outbreak started in 1933 and has since spread rapidly, until at the present time it constitutes a serious menace to the industry.

Symptoms.

The first sign that the roots of a tree are attacked by *Diaprepes* larvae is the yellowing of a part or the whole of the foliage and fruit rapidly followed by wilting and death of the affected part. The leaves may remain attached to the tree in a wilted condition for some time before falling. The symptoms of *Diaprepes* attack may be easily distinguished from those of *Diplodia* dieback as follows: firstly, twigs and branches with *Diplodia* dieback are generally

black in colour and often associated with black blight and scale insects, while a tree suffering from *Diaprepes* injury is a bright yellow brown colour and not necessarily associated with scale insects and black blight. Secondly, *Diplodia* dieback usually occurs in the top or the windward side of a tree while the *Diaprepes* injury may manifest itself in any part of the tree. Lastly, while *Diplodia* dieback is limited to the upper parts of the tree it is generally possible to trace the dead tissue in a tree attacked by *Diaprepes* right down from the wilting branches to the affected roots. It must not be forgotten, however, that *Diplodia* is a common saprophyte and may often occur on the dead parts of a tree killed by *Diaprepes*. In the usual course of the disease one branch or part of a branch dies first, others following at a rate depending on the degree of infestation of the roots. Death is rapid in many instances, there being many records of trees which appeared normal and in good health dying in less than three months.

Examination of the roots of affected trees invariably disclosed evidence of attack by *Diaprepes* larvae which were often found feeding on the cortex of the roots. These larvae eat the cortex down to the cambium, generally travelling along the roots in a more or less longitudinal direction, but sometimes travelling round them. When a root has been ringed or seriously damaged in this way it will die. Many dead roots were found and many of the characteristic scars produced by the feeding larvae were seen, and it seemed probable that the damage done by the larvae was sufficient to have caused the death of the trees. Cultures were made of the fungi present in the dead roots and branches; *Botryodiplodia theobromae*, *Phomopsis citri* and a *Fusarium* species were obtained, the latter fairly constantly, but it was not considered that they were in any way primary parasites. It is possible, however, that certain fungi, including the *Fusarium* sp. and *Sphaerostilbe repens* behave as weak wound parasites or early saprophytes following the weakening of the roots by the *Diaprepes* larvae.

It has been suggested that this new root disease is caused by wilting of the trees in the dry season following death of roots in the wet season caused by waterlogging. Neither the sporadic distribution of the outbreaks of the disease nor the low rainfall, nor the light soil of the lime fields appear to support this view. It is quite probable however that drought will aggravate the disease, since trees which have lost the use of many of their roots will be more likely to wilt in a drought than they would under normal conditions.

The Rootstock.

The majority of the trees attacked by *Diaprepes* are seedling West Indian limes, but budded trees on the rough lemon, sour orange, and Seville sweet orange are also attacked, and there appears to be little or no hope of obtaining any measure of control by the use of a different stock. It would seem, however, well worth while to test budded trees thoroughly under Montserrat conditions. Red root disease, the usual reason for advocating the use of sour orange stock is not at present a major problem, but hurricanes and droughts are major problems to the lime industry and it is probable that the stronger root systems of budded trees would stand up to these better than the seedlings do. The need for caution in proposing a policy of this nature must be emphasised. It is possible that under the dry conditions obtaining in Montserrat the sour orange may not prove the best stock; careful experiments therefore with other stocks including the rough lemon and the Seville sweet orange should be laid down. *Diaprepes* root-borers would undoubtedly v tiate the results of such an experiment, and they must therefore be controlled before any further work of this nature is attempted.

The problem of the control of *Diaprepes* weevils is being investigated by the Entomological Department of this institution and it is as yet too soon to make any definite recommendations.

THE COLLEGE SUGAR FACTORY.

Crop 1936.

By J. G. Davies.

The College Sugar Factory operated for 29 days from 3rd March to 4th April, 1936. During this period, 774.060 tons of cane were ground—478.839 tons being obtained from the Government Farm at Valsayn and 295.221 tons from the area under the control of the College Department of Agriculture. The mechanical operation of the factory proceeded smoothly, the largest item on the "time lost" account being 3.516 hours when the mills were shut down because of the research work being carried out. A comparative measure of the cane quality, factory yields and losses, &c., can be obtained from the following table:—

Table I.

	1936	1935	1934	1933
Pol per cent. Cane	13.84	14.06	13.87	12.44
Fibre per cent. Cane	13.70	14.69	14.23	13.63
Normal Juice:				
°Brix ..	18.95	19.96	19.38	17.53
Purity ..	86.24	82.99	84.42	82.77
Pol Extraction ..	91.15	89.23	89.34	89.29
Boiling House Recovery ..	87.12	85.78	86.23	86.16
Tons cane ground	774	556	659	716
Tons sugar made ..	81.8	57.3	67.5	65.4
Tons cane per ton comm. sugar ..	9.37	9.70	9.76	10.94

An outstanding feature of the latter end of the crop was the high purity of the mixed juice, when this value remained at over 90.00 for eight days or so. Since the factory is only equipped with one coil pan of 56 cubic feet, the high purities resulted in a larger number of re-boilings and a consequent increased fuel oil consumption of 136 gallons per ton of sugar.

During the factory run, ten students received instruction in Sugar Technology in the Factory. The actual tasks undertaken by them depended on whether they belonged to the Third Year or the Fourth Year classes. The former carried out the routine operation and control, and the latter were partly concerned with their research problems and partly with the co-ordination of the factory work.

Two of the Fourth Year Students have investigated in the laboratories the inter-relationship of the phosphate and sulphite concentrations with reference to clarification. This work was sufficiently advanced to allow practical tests being attempted in the factory during the grinding period. It is being extended to one of the commercial factories, after which the results will be published.

Two new processes of clarification were successfully attempted. The first known as the Fractional Liming and Double Heating Process, is designed for raw sugar production, and shows definite advantages as regards (1) Rapidity of settling of refractory juices; (2) Increased purity rise; (3) Decreased mud volumes and (4) Decreased lime consumption. The alterations to an existing factory which would be required to instal this process are not drastic when compared to the added yields and reduced operating costs. The second process—the Bauxite Process, on which provisional patents are held—was operated sufficiently long to obtain syrup to produce one ton of sugar. Owing to lack of suitable equipment, a make-shift method had to be devised to rid the juice of the calcined bauxite after the treatment. Actually, the entire juice was filtered through the mud-presses, and the rate of filtration was such that the limiting factor was the capacity of the feed pump. The sugar obtained was of excellent quality. Acknowledgments are due to the Demerara Bauxite Co. for supplying bauxite for this and the previous work during which the process has been evolved.

NOTE ON THE VEGETATIVE PROPAGATION OF DERRIS.

By O. W. Barrett.

While derris may be grown from seed, the simplest and most rapid method of propagation is by means of cuttings. The species of derris at present cultivated in British Malaya and the Dutch East Indies are particularly well adapted to this method of propagation, since they possess a good, tough cortex, and strong eyes on nearly every well-spaced node. A mature plant of *Derris elliptica* or *D. malaccensis*, two years old, should, from six main withes, yield 100 to 300 two-node cuttings With ordinary precautions, about 95 per cent. of these should " strike " in the field.

Selection.

The optimum age of the vine for cuttings is probably about one or two years, as older plants have much dormant wood. Tender growth from withe tips can, of course, be utilized where " drying-out " and " drowning " can be avoided. In older cuttings, the wood near the base can be forced to sprout—in a matter of weeks, instead of days—with a little extra attention. It is probable that cuttings will in time be taken only from plants which have proved their worth as high-rotenone-content individuals—on a par with the system of budding from " pedigree " Heveas. Prolonged intensive cultivation of *Derris* and *Lonchocarpus* will result in a spread of from 4 per cent. to 16 per cent. of the alkaloids in the roots—(judging from the behaviour of Cinchonas, Para Rubber *et al.*) and the inherent tendency of these plants to vary their rotenone percentages is likely in future to constitute a problem for " Tuba " growers.

Single-node cuttings should not be used unless they can be " spoon-fed ". Whether two-node or three-node cuttings are more economical, considering both the abundance of the plant material and the field conditions, is a matter of circumstances. The base of an old or quasi-" stunted " withe may carry six to ten dormant node buds in the space of ten inches, whereas a vigorous young vine branch may have its nodes eight or ten inches apart. The length of the cutting is thus a secondary matter. Where material is plentiful, " three-joint sticks " are recommended, as their presumably greater vitality will probably counterbalance the advantages in space and handling of the two-node cuttings.

The cuttings should be made with a very sharp knife. If the withes are divided with pruning shears, each end of the cutting should be trimmed clean with a knife to remove any bruised edges left by the shears. The butt end of the cutting should be cut at an angle of 45°, with the point slightly squared-off, from the opposite side of the main cut. In young wood cuttings the base end should be fairly close to the lower node (half an inch). In old wood the cut may be made anywhere between nodes since the roots start from whitish lenticel-like pustules at any point. The tip may be cut at an angle in ripe wood but should be squared off fairly close to the upper node in young wood. The jelly-like pith in young wood either shrinks or rots, according to the weather, down to the node, thus endangering the whole cutting. Dipping the ends in melted paraffin is recommended only for long-distance shipment.

Transportation.

Small quantities of short or medium-length cuttings should be wrapped, in packages of 50 to 100, with waxed paper, and enclosed in some strong paper or cardboard. The cutting ends should be bedded in dampened sphagnum or peat —about " tobacco-moist " or a little wetter. This induces callusing at the cut ends, prevents moulding, and allows of slow sprouting and rooting *en route*. Cuttings so packed can remain viable for six or even eight weeks during transit.

Small tin boxes with small ventilation holes, top and bottom, serve admirably for long-distance shipment, as wood or cardboard boxes may suffer from the moisture in the enclosed material. Failing peat or sphagnum, pellets of dampened paper, or pieces of soaked gunny, may be used. Leaf-mould from the forest floor should never be used, because if hyphae of the thread fungi are present they will attack the bark of the cuttings *en route*.

For large quantities, ordinary wooden packing-cases, without ventilation holes, are safe enough. Cuttings, particularly if they are long or large, may be rolled up in damp gunny-bags or squares of same. To avoid bruising, the bundles must be packed as tightly as possible. Provided these precautions are taken, quantities of 500 to 1,000 cuttings will withstand a trip of two or three weeks—unless " heating " or " sweating " occurs at the centre.

The packages should bear a label, firmly attached, giving the varietal name, date of cutting, &c.; wax pencil on wood (or cardboard) is greatly to be preferred over any ink on any paper.

Cuttings should be dipped in water, preferably warm, as soon as they have been unpacked.

Planting.

Freshly cut cuttings should always be kept in some cool damp place, wrapped in very damp gunny for about a week (or more, in case of old-wood ones) to form the callus. The handling of cuttings which have spent some time in wrappings—paper packages, tins or boxes—will vary according to the case in question. Where the field is not ready for immediate planting, a bed may be prepared for the cuttings. This should be provided with shade which can be increased or decreased according to weather conditions. The soil should be light and mixed with a good proportion of sharp fresh-water sand. Ample drainage must be provided (usually by raising the bed); and watering must be attended to assiduously. The expense of a bed may be avoided by " stratifying " the cuttings in shallow boxes or trays, using peat, sphagnum, or coarse sand (with strips or bits of gunny) to permit the necessary " breathing ". Sphagnum at both ends, with the centres largely exposed to the air, is recommended. The tops of the trays or boxes should be nearly covered with wet sacking; and care must be taken to provide the optimum moisture to prevent bark-drowning on one hand and drying-out on the other. In an emergency cuttings may be rolled up in small parcels with wet gunny.

In most cases, vigorous cuttings, showing sprout-buds, or even root-threads or " points " may economically be planted out in permanent position upon receipt, except, as explained above, in the case of freshly-cut cuttings.

If planted in permanent position before shoots or roots are well started, a handful of sharp river sand should form the " bed " of the cutting, particularly about the butt. Whether planted in " nests "—one, two or four to the pit, or hill—or in ridged trenches, the cutting should be so set that its tip protrudes an inch or two while the butt is sunk two to four inches below the soil surface. The tip should be wrapped in a wisp of sphagnum —or at least protected with a handful of chopped straw or grass. A sprout appearing at any node must be covered lightly with some sort of mulch until it turns green.

Branches stuck slantingly over the planted cutting keep stray fowls and dogs from injuring the young shoots which may grow an inch a day after the cutting establishes itself. In dry weather a light chopped straw mulch helps to keep the cuttings from the heat. In prolonged rainy weather, dormant cuttings may require raising an inch or two or re-setting to avoid " drowning ".

Although it may be years before a specific cultural technique is standardized for derris in the Western Tropics, the writer believes that some modification of the " layered ridge-trench " method which he worked out at the United States Agricultural Experiment Station, in Mayaguez, Puerto Rico, will be adopted. To facilitate harvesting a root crop, and to stimulate rapid root growth, this method is advised.

A trench is dug about two feet wide and about 18 inches deep; a three-inch layer of trash (chopped grass, coarse horse dung, or even leaves or straw) is put in and covered with about four inches of earth. This is superimposed by another layer of horse dung, grass or " trash " and another layer of soil. A layer of well-broken-up pen manure, ashes, or some sort of slow fertilizer is spread just below the original soil surface; and the trench ridged-up about a foot above the old surface. By " caving-off " the sides, in filling, the middle portion of the trench will be nearly three feet wide, and the flat or convex top of the ridge will be about two feet. Each linear foot of the trench will thus give about five cubic feet for the root. By planting the cuttings 18 inches apart (diagonally across) on the trench ridge, and making the trenches six feet apart, centre to centre, the plant will have the nine square feet of ground surface which is about the average area allowed for a plant in British Malaya.

Another method which may prove of merit in some soils is the " nest ". Pits 24 by 24 by 20 inches, and six feet apart, centre to centre, with four cuttings per nest, allows the regular (?) nine square feet above ground, but only about $1\frac{2}{3}$ cubic feet for the plant's root-system.

In ordinary soils, no hole or trench should be over 18 or 20 inches deep, for obvious edaphic reasons. The width and length of the space allotted to the root-system depends largely upon the planting outlay and the probable harvesting economy; but the problems of the culture and cropping of derris in the Western Tropics have much dimmer purlieus than the question of propagation by cuttings.

STOCK REARING IN THE TROPICS.

[*The following notes are based on information supplied by J. D. Brown,* B.Sc., *of the Nigerian Agricultural Department, from experience obtained in the management of a herd of cows and their calves at the Department Stock Farm at Shika, Zaria, Nigeria.*]

Management of Cows.

All cows are dried off six weeks before calving, or earlier, if their milk yield drops below 25 lb. When a cow is dried off, she may be given a dose of 1 lb. magnesium sulphate, though usually this is not necessary. She is then drafted into the dry cow herd, where she remains on dry cow rations until a month before she is due to calve. She then returns to the milking herd, and comes into the milking shed twice daily, along with the milking cows, and receives milking cow rations on the basis of a yield of two gallons. If she has had a calf before, she requires no further attention before calving, but if she is a calving heifer, or a known heavy milker, she has her udder washed and massaged twice daily, and is lightly milked for a week before calving. Such ante-natal milking should, however, be done very gently and care should be taken to avoid causing pain and consequent apprehension.

A good deal of importance has recently been attached to this question of pre-natal treatment at Pusa, where experience with the Sanhiwal herd has indicated not only a considerable increase in milk yield, but also a remarkable freedom from udder trouble. It is claimed, as an additional advantage, that this treatment makes the cow much more amenable to letting down her milk without the calf. It is not considered at Shika that at present this question is one of much importance. All that is wanted is to secure that the mammary glands are stimulated sufficiently to start secreting fully and immediately the cow calves. It would be most beneficial no doubt, in the event of any congestion of milk, sufficiently great to be likely to cause udder trouble, but this is of extremely rare occurrence with native cows. It is not considered therefore that the practice is worth the amount of extra work involved. By keeping a calving list, prepared month by month, some time ahead, it is possible to ensure that all heifers due to calve come up for observation in due course.

One week before an animal is due to calve, she is transferred into the calving pen. This should be kept very clean, the walls whitewashed after each calving and soiled litter removed daily. During this week the cow is given an extra supply of *dusa** to keep her bowels free, and if there is any sign of constipation, she should be given ¾ bottle of linseed oil.

At birth the calf's cord is not ligatured but is cut off, washed with a lysol solution and painted with iodine. Previous experience with tying the cord has been unfortunate. The afterbirth should come away of its own accord within 24 hours, but no action need be taken up to 48 hours. If at the end of this time it is still adhering, it has been found of assistance to twist the end of the afterbirth round a piece of stick and by twisting, exert slight pressure. This twisting should be increased hourly or a small weight attached, and in nearly every case the afterbirth will come away by itself. On no account should attempts be made to hasten its exit by hand, as it is most likely that inflammation will ensue, and the cow almost certainly become barren, while there is a considerable risk of the operator getting an unpleasant skin infection.

Up to a few months ago, it was the custom to leave the calf with its mother for two days and two nights and not start milking proper until the third day. (Every cow, of course, is milked a little immediately she calves, in order to ensure a free flow for her calf.) This practice has been criticised on the ground that it leads to the holding up of milk and reacts adversely upon the cow's ultimate yield. On the other hand, it is held by some that by removing the calf from the mother at birth, its health was being prejudiced, by its being deprived of its natural self-prescribed ration of *colostrum*. However, the length of the suckling period has been gradually reduced, without apparent harm to the offspring, and at the time of writing, all calves are removed from their dams at birth. Instead of *colostrum* the calf gets a laxative on the first three days of its life: on the first day one teaspoon of linseed oil, on the second day the same plus one teaspoon of castor oil; on the third day the castor oil is increased to three teaspoonfuls. This amount of laxative seems to get rid of the *meconium* fairly well, and since the welfare of the calves is the major concern at Shika, the new routine is firmly established.

When the cow calves she continues to receive rations at the rate proportional to a two-gallon yield. In actual practice, she is fed *ad lib.* for some four weeks after calving, or until such time as she has definitely passed the crest of her flow. One's aim should of course be to reach that maximum as quickly, and to maintain it as long as possible. This can only be done by giving every newly-calved cow individual attention, and by breaking down any tendency on her part to hold up her milk by milking her frequently. With calving heifers, it is often necessary to milk up to ten times a day, before one can be certain that no milk is being withheld, and *all* cows are milked at least five times daily for the first three weeks of their lactation period. In spite of all care, blind quarters are occasionally found, and experience here is that it is better to get rid of such animals at once, as treatment is nearly always unsatisfactory. It is difficult, if not impossible to cure, and there is no known formula for making the necessary correction in the record of the cow's milk yield. Care is taken to see that as soon as a cow's milk yield drops, her rations are proportionately reduced, as otherwise she is simply putting on unnecessary fat.

* Bran of guinea corn (*Andropogon sorghum*).

Calf Rearing.

When the calf is taken away from its mother it is put into an individual calf-pen and well bedded down. Each pen has a ticket showing weight at birth, and weekly increases of weight. The calf remains in these pens for one month or until it has to make room for a new arrival. During that period it receives its mother's milk at least three times per day. If the cow will let down her milk without her calf so much the better and this is a tendency which is very strongly encouraged. Roughly, the following quantities of milk are fed to calves:—

Birth to 1 month	.... 5 lb.	per day.
1 - 2 ,,	 6	do.
3 - 4 ,,	 8	do.
5 - 7 ,,	10	do.

These quantities vary with individual cases, and it is better during the first month of a calf's life to err on the light side, as a calf's stomach is unable to cope with large quantities of milk. The milk after being drawn from the cow is heated up to blood-heat before being fed. All calves have free access to bran from birth and although they seldom touch it during the first two weeks, it is advisable to have it there. The total amount of milk fed to a calf is about 175 gallons.

From the individual pens the calves are moved into a pen at the side of the milking shed, holding from four to six animals each. As soon as an individual pen is vacated, the floor is washed out with a disinfectant solution, and the walls re-whitewashed before a new tenant enters. At one time the calves that had to go into the milking shed to induce their dams to let down milk, were segregated from those that never entered it, but this is no longer done. From these pens the animals move into one or other of three pens where they are graded according to size and age; a fourth pen is reserved for convalescent cases while they are segregated from their fellows. Good housing in the dry weather, when the diurnal variation of temperature is great, and the early hours of the morning quite cold, plays an important part in keeping the calves healthy.

The calves are drafted from this last series of pens when they reach eight months old, and here the first segregation of sexes occurs. Calves have in the autumn been drafted straight into the feeding experiment, but during the spring and summer months, the sexes are penned separately. The females are taken into the Dry Season Feeding Experiments, while the males out of inferior dams are castrated.

As soon as heifers are served they go into the "calving heifers" herd where they get special feeding as laid down in the table of rations.

In the early autumn (September) the castrated males are handed over to "mixed" farmers through the Superintendent of Agriculture concerned.

Before a calf is one month old it should be drenched once with turpentine and linseed oil against round worms (6 ozs. turpentine in 20 ozs. linseed).

After it is one month old it should be drenched against wireworms with copper sulphate and mustard at fortnightly intervals, at rates varying with weights. Drenching with copper sulphate and mustard every fortnight is routine for calves, sheep and goats throughout the wet season and up to the end of November. It is considered worth while drenching at 4.30 a.m. or earlier, in order to give the drug a fair chance of acting before the morning milking.

The dangerous time of a calf's life is from birth till six weeks old. During that time they must be watched most carefully. The first sign of anything wrong is usually diarrhoea. When this occurs the animal should be put straight into the "hospital", dosed with castor oil, and not given any milk for 12 hours. If at the end of that time there are signs that the scour is lessening, small quantities of milk and hot water (50/50) may be fed at intervals of three hours, but the animal should not be put back on its full rations too soon. In some cases this treatment will cure in a day or so, but unfortunately, in the majority of cases, convalescence is a very long business entailing constant supervision. Many different measures have been tried, with varying success, but prevention is better than cure, and the secret of successful calf-rearing is considered at Shika to be cleanliness, cement floors, and absence of overcrowding until the calves are over two months old. Towards this end, it is essential, among other things, to see that all calves have clean litter, that the udder of each cow is properly washed before she is milked, that the calf's mouth is washed and dried after it has had its drink (this lessens the attacks of flies and reduces the loss of hair round the mouth), that milkers wash their hands frequently during milking time, and above all, that buckets should be well washed between individual milkings. To avoid overcrowding, draft the biggest calves into the segregation pens as soon as possible.

External parasites (lice and fleas) need not be anticipated until the animal is two to three months old and is living on a floor of litter. A daily inspection of the animals should then be carried out and whenever lice are noticed, the stock should all be dipped with arsenic dip (1 in 250) in a small bath. At the same time the bedding should be burned and walls re-whitewashed. Other dips have been tried such as emulsified soap and kerosene, tobacco and mustard, but Cooper's arsenic dip seems the most satisfactory. Care should be taken to see that young calves do not get chilled and therefore the dip should be slightly warmed, the animals should be dried afterwards, and the dipping should not be done very early in the morning.

Feeding of Cows.

The West African Zebu cow in the hands of the Fulani herdsman leads a nomadic life grazing from one part of the country to another, being forced by the drying-up of streams and water-holes to move southward as the severity of the

dry season increases in the more desiccated north. Poor as the natural grazing is known to be for eight months in the year, the Zebu cow exists on it alone and receives no concentrates. If she exhibits signs of 'pica', she may be given a little native cattle 'lick', consisting of salts of soda and potash, but that is all. In these circumstances, reproduction entails a severe drain on her constitution, and the loss in body-weight during her lactation period is appalling. Among native-owned herds, annual calving is exceptional, biennial and triennial calvers being the rule, and it seems fairly certain that this reluctance to breed regularly and often is an inhibition evolved by the animal through generations of privation, to combat the hard conditions in which she has her existence.

From investigations carried out among the Fulani, it seems accurate to state that the milk yield of their cows varies in inverse proportion to the periodicity of calving. One factor which practically by itself will upset this correlation, is the adequate feeding of balanced rations, and it has been proved at Shika that if this is seen to, the bulk of the cows will (and do) calve down regularly once a year.

The whole aim in fixing the rations of the breeding stock is therefore *so to maintain their condition that their milking performance is a true record of their capabilities.* This applies equally to young female stock as to mature cows, for if an animal's development is retarded at any period of its life prior to or during the time it is recorded, it not only affects its own record but masks the true value of its sire. All animals (except the working stock) are weighed at monthly intervals and an inspection of these weights enables one to see whether an animal is doing properly or not.

Feeding of Breeding Bulls and Working Bullocks.

While a bull is running with a herd of cows, he is fed *ad lib.*, regardless of season. This is to ensure that he keeps in good form, for if he allows a cow to come in season without serving her, then he is seriously affecting her record.

During the cropping season (April to August) all working beasts should be fed *ad lib.* They have to work very hard indeed, especially at the beginning of the season, and unless personal attention is given to their feeding they will be unable to stand up to their task. Their health must also be watched, and though fortunately at Shika, there has been very little serious sickness, apart from the usual sprains, cuts and abrasions that require no special mention, there is always the risk of trypanosomiasis. All likely breeding grounds are regularly cleaned and there is consequently no 'fly', but there is always the risk of mechanical transmission, in view of the fact that the majority of the animals here is purchased stock.

Liver flukes are however abundant, and a *post mortem* never fails to show this parasite or indications of its presence. All marshes and drinking pools are treated with copper sulphate (one part in a million) at three monthly intervals to kill the snail hosts. Animals that appear to be infected are treated with small doses of tartar emetic, only slightly more than half the doses generally recommended for animals suffering from trypanosomiasis.

THE BIOLOGY AND CONTROL OF TERMITES.

A Review.

Specialisation is at once the curse and the salvation of entomology—the curse because it makes it increasingly difficult for those who are compelled by economic or other considerations to keep pace with the general progress of their science; and the salvation because without it so vast is the subject becoming, no progress would be possible. There is one thing which the general worker, the zoologist and the naturalist, if they have not the right to expect, at least are prone to desire from the specialist, and that is an occasional attempt to present his subject in general terms. It is obvious that the specialist, if he fortunately be one who can see and appreciate the wood in spite of his concentration on the trees, is the best person to describe it.

Dr. T. E. Snyder, Senior Entomologist of the United States Bureau of Entomology and Plant Quarantine, has been studying termites from every point of view for 26 years. His colleagues, friends and correspondents who have benefited by his ready advice and prompt identification of specimens sent to him from all parts of the world have long wished that he would put in book form the main conclusions of his long and varied experience with these most interesting and important insects. This he has now done in the form of a book entitled "Our Enemy the Termite" (Comstock Publishing Co., Inc., Ithaca, New York 1935, xii+[2]+196 pp., 10 plates, 56 text-figures; price $3). Such a work is the more welcome since popular or general books on the biology of termites, unlike those devoted to ants, bees and wasps, are distinctly rare. The scarcity and finally absence of termites as one proceeds north in Europe largely debarred them from the attentions of the great popularisers of insect biology—Lubbock, Fabre and others, though Maeterlinck devoted a volume to their biology. Dr. Snyder's book has a wide appeal since it not only describes the romance of their strange social life, but also presents in compact form a mass of information on most points of their biology and supplies a useful guide for the prevention of their damages to the works of man.

The format of the work is pleasing—and the illustrations, chiefly photographic, are well reproduced. The first chapter deals with the classification and distribution of termites, with fossil forms and with the termite descent from cockroach-like ancestors. No fossil termite has yet been found more primitive than the still living Australian *Mastotermes*, which recalls the cockroaches in several points of anatomy and behaviour.

The second chapter sets forth the individual life-history and describes the termite castes—workers, soldiers and reproductive adults. That it is very far from an academic study is shown in the account of a day's collecting in Panama, the final activity in which—our writer was then new to the Tropics—consisted in climbing a tree to a particularly interesting-looking termite (?) nest. "A brier-like vine growing on the trunk penetrated my skin and when half-way up a small nest of wasps . . . was disturbed; the wasps stung me viciously. I fell down from the tree. Still determined, I knocked down the cone-like nest with a branch and broke into it. Out swarmed legions of a tropical ant (*Azteca* sp.) which soon covered me, biting viciously. I had expected to find termites in this nest. Chagrined, I turned away just in time to see a bull charging towards me. I fled and climbed the fence. Covered with young or seed ticks which were boring into my skin, and itching with 'Chigger' or red bug bites, I called it a day."

The foundation of a new colony, beginning with courtship and the colonising flight is the subject of the third chapter, while the fourth is a concise account of the different types of termite nests.

The food of termites, dealt with in the next chapter, brings in a discussion of very exact tests performed in Panama and elsewhere into the relative resistance of various timbers to termite attack. A short chapter—all too brief—considers the very interesting relations of termites with the guest or inquiline insects living with them in the nests. Here the use of the term "wasps" for the bee genera *Megachile* and *Euglossa* is incorrect, and has not the excuse that no other English name is available, since they are so typically bees. Why also the true parrots which make nest-holes in termitaria should be described as "parrot-like birds", it is difficult to guess.

The next chapter, showing how termites have become pests owing to the "disturbance of the balance of nature by man", leads up to Chapter 8, where the damage by termites to woodwork is described with many striking illustrations. The admittedly incomplete list on pp. 113-114 of the materials termites have been known to damage is amazing in its bizarre variety—from gunpowder to mummies.

Chapter 9 describes the natural enemies of termites and shows how varied and abundant these are, though biological control engineered by man has as yet made but a poor showing against any of the social insects. Against termites especially we have to rely almost entirely on artificial means of control and prevention, and these are detailed at considerable length in Chapter 10 and the useful and technical appendix of building instructions and code amendments. Here the mark of authoritative experience is evident on every page.

The addenda contain a table (not a list as stated) of termite-species of the world and a list of the species (56 in all) occurring in the United States.

The glossary which closes the book is a curiosity of entomological literature. It is beyond the wit of the reviewer to suggest why a reader educated enough to wish to read the book or even literate enough to be able, should require a definition of such ordinary English words as anus, arboreal, breeding, dorsal, diffused, excrement, exotic, fossil, parasitic, progeny, saliva, sensory, serrate and symmetrical to name a few which are typical.

The book should be both useful and interesting to the general entomologist and to the informed public.

J. G. MYERS.

AIR-CONDITIONING IN THE TROPICS.

Atmospheric conditions in the tropics have serious effects, both physical and mental, upon the inhabitants. In an article in the *Electrical Review* of 8th November, Prof. C. A. Middleton Smith of the University of Hong-Kong states that it is difficult for those who live in temperate regions to realise the depression produced on human energy by living for months in a climate with a night and day temperature of about 90°F. and a relative humidity of more than 90 per cent. With the help of electrical power and the new methods of producing cold mechanically, it is now possible to manufacture climatic conditions that are almost perfect. By the use of a small electrically driven machine in his private room in the University, Prof. Smith can make the climate in it as pleasant as on a summer day in England. Six hours after the machine has been at work, it has extracted a gallon and a half of water from the air in the room. The effect of the two contrasting atmospheric conditions within and outside the room upon bodily comfort is most marked, and he has found by experience that he can double his lecture hours and yet be less fatigued at the end of the day. He says that no educated person in the tropics who can afford an electrically driven refrigerator would now risk having a 'disease carrying' ice box. He has for the last sixteen years advocated air-conditioning in the tropics. One of the most extensive applications of the system in China to-day is that of the new million pound building of the Hong-Kong and Shanghai Bank. There are six air-conditioning plants for the whole building. Electric motors are used for driving the ammonia compressors. Three pumps are required for the condenser water circulation and there are six inlet fans which drive 229,000 cubic feet of air a minute. The total rating of the electric motors used is 800 horse-power.—(*Nature*, Vol. CXXXVI, No. 3449, p. 905, 1935.)

OBSERVATIONS ON THE EARLY LARVAL MORTALITY OF CERTAIN SPECIES OF *DIATRAEA* (LEPID., PYRALIDAE), UNDER CANE FIELD CONDITIONS IN TRINIDAD.*

By Alan Pickles, M.Sc., A.I.C.T.A.
(*Entomologist, Trinidad Department of Agriculture*)

1. Introduction.

It is a matter of common knowledge that in the case of many species of animals, progeny are produced in vast numbers of which but few can possibly survive to maturity. While some part of the mortality, of which this low survival rate is evidence, is often due to the activity of parasitic and predacious organisms, other factors frequently play a large part in reducing the rate of animal increase.

In the first place, the very abundance of the young individuals produced in one generation sets up an element of competition between them. This is particularly evident when the organisms are confined to one host and when, in addition, they possess feebly developed powers of locomotion. Thus in the case of *Salpingogaster nigra* Schiner, which in Trinidad is predacious on the nymphs of *Tomaspis saccharina* Dist., it has been shown that under cane field conditions, the control effected may be much below expectation, since the occurrence of several larvae in one stool of cane forces the insects into competition with one another for food (8, p. 6).

Again, while there can be no doubt that remarkably efficient morphological adaptations to the environment occur, the fact remains that physiological adaptation is often much less efficient. Indeed, contemporary ecological and physiological investigations show that, so far from living in an optimum environment, many organisms occupy a habitat of which the physical conditions represent the limit of those which can be tolerated.

The fact appears to be then, that in a number of cases survival to maturity occurs, not because an extremely favourable adaptation to environment has become established in the organism, but because individuals are produced in such great numbers that some at least are able to take advantage of chance fluctuations in the rigour of environmental circumstances. In the parlance of one ecological school, a small population of individuals can survive in spite of high "environmental resistance", because "biotic potential" is also high (3).

Accordingly, it is not surprising to find that in the case of many crop pest insects, for example, a very high non-parasitic mortality occurs. Doubtless similar phenomena occur in a state of nature but it is in the case of pest insects that the fact is most noticeable and is also most easily investigated. A high death rate of this nature, occurs for instance, in the case of the eggs of *Tomaspis saccharina*, of which some 90 per cent. die in the course of a normal dry season in Trinidad (9). Similarly, in the case of *Diatraea saccharalis*, a high mortality of the newly hatched larvae has been observed by Cleare (quoted by Myers, 5, p. 311), and this observation has been confirmed by Box in Antigua (1) and by Tucker in Barbados (14).

For comparison with these results, it was considered a matter of some importance to make similar observations in Trinidad on the three common species of *Diatraea* which occur in the cane fields and to investigate the probable influence of such mortality on the progress and economic effect of parasitic factors of control.

2. Theoretical Aspects of the Influence of Host Mortality on Control by Parasites.

In a discussion of the methods employed in Barbados for the control of *Diatraea*, and of their early results, R. W. E. Tucker (12, 13) stated that, in consequence of the mass liberation of the egg parasite *Trichogramma minutum* Riley, 11.1 per cent. more of the *Diatraea* eggs were parasitised in the field than had been parasitised during the year prior to the inception of this work. He also suggested that in consequence, there appeared to be a sensible reduction in the damage to the canes.

This statement has been rather severely criticised (*e.g.* 1, 2, 5, 6) on the grounds that, since a large proportion of the newly hatched *Diatraea* larvae, estimated at 90 per cent., will die even if no egg parasites are present, 11.1 per cent. more host eggs killed by parasites only contributes 1.11 per cent. more to the total "real mortality" (11) of *Diatraea*. While this interpretation of the effect on "real mortality" is correct, it is by no means clear that an appreciable economic benefit would be impossible in the circumstances. Moreover, if this argument is a real objection to the employment of egg parasites, as Myers (7) suggests, it is clear that the same objection would apply to parasites of later stages (15) or indeed to most methods of insect destruction.

From the strictly practical standpoint, the effect of control measures is more clearly appreciated from a study of the effects on insect populations which survive than from the influence on mortality. For the criticisms of Tucker's work to be valid, the reduction in *Diatraea* populations should be of the same order of magnitude as the changes in total *Diatraea* mortality, and not of the same degree as the changes in egg parasitism. The specific problem before us is, with larval mortality at 90 per cent., will an increase of 11.1 per cent. in the parasitism of the eggs reduce the surviving *Diatraea* population by 1.11 per cent. or by at least 11.1 per cent.?

* From a thesis submitted for the Degree of Master of Science in the University of Leeds, 1935, and published by permission.

While the point in question appears to be quite simple, a more detailed examination of the problem appears to be desirable, in view of the importance of the matter to general principles of biological control (7, pp. 185-6).

The general case may be examined most conveniently by employing algebraic notation to represent the various quantities involved in the discussion. Suppose that x insect eggs of a given species are originally laid in a closed habitat. Suppose further that a proportion equal to a of the eggs is killed by a lethal factor (egg parasites, for example) that a proportion b of the survivors is killed by another factor and that successive survivors are killed in turn in proportions of c, d, e, &c., but that no two factors act simultaneously, and that the operation of any factor is quite independent of the others and of the magnitude of the host population.

Then, the number of hosts finally surviving to cause economic injury will be :

$$x(1-a)\ (1-b)\ (1-c)\ \ldots\ (1-n) = P_1 \text{ (say).}$$

Now suppose that any one of the lethal factors is increased, so that one particular stage of the host is subjected to a greater mortality than before, whereby d, for instance, is increased to $(d + q)$ the other factors remaining unchanged. The surviving population will now be :

$$x(1-a)\ (1-b)\ (1-c)\ (1-d-q)\ \ldots\ (1-n) = P_2.$$

The originally surviving population has been reduced by a proportion equal to $\frac{P_1 - P_2}{P_1}$, which on substitution and simplification becomes $\frac{q}{1-d}$.

This expression, it will be observed, does not involve the original host population, nor any of the mortality factors which remained constant. When q and d are positive quantities, this expression is always at least equal to q, from which it may be concluded that the reduction in host population is always at least as great as the augmentation in the lethal factor. The efficiency of a parasite of any stage of an insect, in other words, is uninfluenced by preceding or succeeding host mortality.*

It appears then, that while Tucker's original statement, which was contained in reports for non-technical readers, is not particularly informative as it stands, there is nothing in it which is incompatible, as has been suggested, with his claim of possible economic results. A similar conclusion might, of course be derived in other ways, as Tucker (15) has already shown from a consideration of Thompson's treatment of the question of real and apparent mortality (11).

3. Experimental Determination of Larval Mortality in Trinidad.

(*a*) METHODS.

The methods followed in the estimation of the larval mortality of *Diatraea* are based on those described by Tucker (14) with some slight modification. Small plots of sugar-cane were selected for study each month and the plants were minutely examined at least twice weekly during the month. The number of eggs found on each cane stool at each examination was recorded and the position of the clusters was indicated on the plant by a special paint mark, so that any particular egg cluster mentioned in the records could be readily identified. The subsequent history of the eggs was followed and records were made of the number which hatched normally, which were attacked by parasites or which failed to hatch for other reasons. At the end of the month, the canes were reaped and examined for *Diatraea* larvae. At the same time, the leaves were examined for traces of the eggs which might have escaped notice earlier in the month. It may be mentioned at once that the number of eggs overlooked in the course of the routine observations was extremely small.

Knowing the number of eggs which had hatched normally in each plot during the month, and also the number of surviving larvae, it was possible to deduce the proportion of the larval population which had died.

These methods naturally introduce the possibility of rather large errors. In the first place, it is doubtful to what extent the small plots could be regarded as adequate samples of the area. Secondly, errors would arise if larvae migrated out of the plots after hatching, or if immigration of larvae occurred from outside. It has been assumed, however, that the number of larvae emigrating from the plots would be balanced by the number of immigrants. In order to obtain some idea of the uniformity of the results, three plots, selected at random, were examined each month. Each plot contained a maximum of thirty stools, but owing to occasional failures, the plots frequently contained fewer plants.

* This reasoning is not always apparent to those not accustomed to algebraic methods of argument. By way of illustration, we may give actual numbers to the quantities employed in the example. Suppose that there are 10,000 *Diatraea* eggs in an isolated habitat, of which none is parasitised in the first instance, but that 90 per cent of the larvae which hatch are killed. Then, since there are no egg parasites, 10,000 larvae will hatch, of which 90 per cent. or 9,000 will die and 1,000 will survive. Again suppose that there are 10,000 eggs, but that 11 per cent. of these are parasitised. In this case, 1,100 eggs will be destroyed by parasites and 8,900 will hatch. Of the survivors, 90 per cent. or 8,010 will die and the final population will be 890. Through the action of parasites, the final population has been reduced by 110 from 1,000, that is, by 11 per cent. In these terms, the argument of the critics of the utilisation of egg parasites would be : in the first case, the total mortality of *Diatraea* is 90 per cent. ; in the second case, it is 91.1 per cent. Therefore, although egg mortality has been increased by 11 per cent., total mortality has only increased by 1.1 per cent. The view developed in the present paper is that small changes in total mortality may reduce host populations by large amounts.

A diagram of the experimental lay-out is appended (fig. 1). Thanks are due to Mr. J. H. Taylor for permission to conduct the experiment at Orange Grove Estate.

E

1 Nov.	24	25 Jan.
2 Sept.	23 July	26
3	22 Sept.	27 June
4 Dec.	21	28 July
5	20 Oct.	29 Dec.
6 Oct.	19	30
7 Jan.	18 June	31 Nov.
8	17 Nov.	32 Oct.
9 July	16	33 Aug.
10	15 Dec.	34 Sept.
11 June	14 Aug.	35
12 Aug.	13 Jan.	36

N S

FIG. 1.—*Diagram of arrangement of field plots.*

The observations cover a period of eight months, from June, 1934 to January, 1935. Further work was impossible after this date owing to estate reaping operations in the selected field.

(*b*) LIFE HISTORY STUDIES.

In conjunction with the studies in the field, an investigation was made under laboratory conditions, of the life histories of the species of *Diatraea* concerned. Since pupae and empty puparia were frequently found in the canes, in addition to larvae, it was essential for the interpretation of the results, to know if these could possibly be derived from eggs laid during the same month. It was also necessary to determine if individuals could emerge and escape as adults within the space of one month, as such would not be recorded as survivors.

Sugar-cane in Trinidad is commonly attacked by three species of *Diatraea* which are, in the order of their abundance, *impersonatella*, *canella* and *saccharalis*. In order to determine the length of the life cycle, individuals of each species were reared to maturity.

As opportunity offered, males and females *in coitu* were captured in the field or at light, and the females were allowed to oviposit in glass-bottomed boxes. The air in the boxes was kept slightly moist by introducing a piece of damp filter-paper into each. As the eggs hatched, the larvae were transferred to pieces of fresh cane leaf and later, as the larvae increased in size, to sections of hard cane. On pupation, the insects were removed to tin boxes containing moist *bagasse*. The insects during development were examined at frequent intervals and the occurrence of every moult was recorded. By keeping records of the length of the larvae at each examination, it was possible to ensure that no ecdyses were overlooked.

It was found that a high mortality of larvae and pupae occurred under these conditions and efforts to eliminate this by variations in the technique met with no definite success. Accordingly, the number of individuals which were successfully reared from oviposition to maturity was limited, but the results so obtained were confirmed by observations on part of the life history from other specimens.

The number of larval instars was subject to some variation, probably owing to the artificial conditions in which the insects were kept. The usual number, however, appears to be seven or eight in the case of all three species, and only in one case, a specimen of *D. canella*, were as many as ten edcyses recorded.

(i) *Diatraea saccharalis*.—The incubation period of the eggs occupied six days in all cases; larval life, during which seven moults occurred, accounted for thirty-nine days and adults emerged nine days after pupation.

(ii) *Diatraea impersonatella*.—The incubation of the eggs occupied six days, as in the case of the preceding species. The duration of larval life was somewhat irregular, and varied from twenty-two to fifty-three days, with a mean of thirty-seven days. Pupation occupied from nine to eleven days.

(iii) *Diatraea canella*.—The life history of this species appears to be definitely longer than that of either of the preceding. Incubation of the eggs lasts for seven or eight days and larvae remain as such for forty-eight to sixty-eight days. The period from pupation to the emergence of the imago occupies about twelve days.

From the foregoing studies, it is evident that in no case could any pupae found in the experimental canes be derived from eggs laid during the same month. The minimum time which must elapse between oviposition and pupation is twenty-eight days and the usual interval is considerably longer. A period of thirty days would appear to be a suitable one to select for the interval between the commencement and the close of one set of observations.

(c) Results.

The data which were obtained by the experimental methods discussed above are summarised in Table I.

Table I.

Month.	Plot.	No. of stools.	No. eggs laid.	No. eggs hatched.	No. larvae surviving.
June ..	11	28	196	67	19
	18	23	191	116	20
	27	20	98	29	19
July ..	9	25	273	81	5
	23	20	88	38	4
	28	17	119	21	9
Aug. ..	12	27	160	115	36
	14	24	140	59	26
	33	19	67	24	15
Sept. ..	2	24	252	55	12
	22	23	189	88	16
	34	21	408	198	23
Oct. ..	6	24	525	382	15
	20	23	896	685	14
	32	24	415	297	14
Nov.* ..	1	26	566	489	20
	17	20	230	149	35
	31	20	547	505	22
Dec. ..	4	19	262	124	13
	15	20	262	233	28
	29	18	432	380	38
Jan. ..	7	28	944	524	44
	13	28	892	552	44
	25	30	577	298	44

* See footnote in next column.

The monthly rainfall during this period, measured by the gauge in Orange Grove factory yard, about a quarter-mile distant from the experimental area, was as follows.

Month.	Rainfall (inches).
June	1.52
July	5.43
August	6.85
September	6.93
October	13.91
November	12.89
December	5.24
January	1.14

(d) Discussion.

From Table I three values may be calculated to represent the larval mortality which occurs per month. The mean of these values is the most representative estimate available and mean values so derived are shown in Table II.

Table II.

Month.	Mean Laval Mortality per cent.
June	73.31
July	80.15
August	54.04
September	82.79
October	95.56
November*	89.39
December	89.17
January	89.63

The mean monthly mortality of young *Diatraea* larvae over the period studied is thus 81.75 per cent. The results unfortunately do not cover a single complete year, but if it is assumed that the mortality in each of the four months not covered by these records was as high as 100 per cent., the mean value for one year becomes 87.84 per cent. This value is still considerably below Box's revised estimate of the average monthly mortality of *Diatraea* in Antigua (2), which he gives as 97 per cent. In Barbados, Tucker (14) gives the mean of nine month's determinations as 71.06 per cent. Assuming that the mortality in each of the three months which were not studied was 100 per cent., the average Barbados figure becomes 78.29 per cent., a value which is much lower than that found for either Trinidad or Antigua.

Some difference is to be expected, of course, between the results of these three experiments. In the first place, the experiments in Antigua and Barbados were concerned solely with the one species, *Diatraea saccharalis*; in Trinidad three species were involved, of which *D. saccharalis* was the least plentiful. The great climatic differences existing between the three islands in which experiments were conducted, and important variations in the methods of cultivation, would also prevent the results from being strictly comparable.

If the percentage mortality of larvae in any month be compared with the number of eggs laid on each stool during the same month, it is observed that in general, the greater the number of eggs laid, the greater is the larval mortality. This is shown in Table III, where the mean egg population per stool is given for each month, in ascending order, against the corresponding larval mortality The result is also shown graphically in fig. 2.

* Mr. Tucker considers that results after October are unreliable, as the canes are then so tall that accurate examination is impossible. In the present case, this objection does not apply, since the canes employed in the experiments, for many reasons, never became particularly luxuriant so as to interfere with examination.

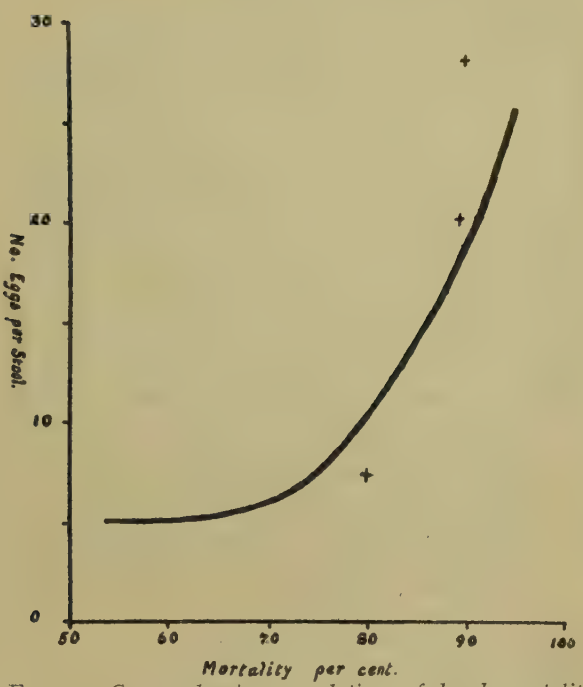


FIG. 2.—*Curve showing correlation of laval mortality with number of eggs laid (Trinidad experiments).*

Table III.

Month.	No. eggs per stool.	Larval mortality.
August	5.09	54.04
June	6.73	73.31
July	7.44	80.15
September	12.72	82.79
December	16.96	89.17
November	20.21	89.39
October	26.04	95.56
January	28.26	89.63

A more precise comparison of the figures is obtained by calculating the correlation coefficient from the observed figures (4). This is found to be 0.811, indicating that larval mortality is positively correlated with the egg population. A coefficient of this value might be obtained by random sampling from unrelated populations less than once in a hundred times (*loc. cit.*)

Similar examination of the experimental results obtained by Tucker (14) shows that the correlation coefficient in this case is 0.631, a value which falls just short of the usually accepted 20 per cent. level of significance. There is an indication then that the correlation may also hold under Barbados conditions.

Interpretation of this result is a matter of some difficulty since nothing is known at present of the causes of larval mortality from qualitative studies. Two possible suggestions to explain this correlation may be mentioned, which it is hoped to examine in the course of future work. It is possible that one important factor in causing larval mortality is competition for feeding areas between the larvae themselves. This would result in more intense competition when the early larval populations are large and would thus account for the correlation. While there is little evidence in the present results to invalidate such a conclusion, the evidence does not tend in this direction. If larval competition is a major factor in determining larval mortality a higher value of the coefficient of correlation should be obtained when the number of larvae actually hatched is compared with the larval mortality, than when the number of eggs laid is so compared. In the latter case, as has been shown, the coefficient is 0.811; in the former case, the coefficient is only 0.781.

A second possible explanation might be found in a study of the influence of climate on populations and on mortality. Thus, if a certain climatic factor favours oviposition and also is unfavourable to larval development, the correlation might again become explicable.

It would appear to be a matter of some importance to investigate the first of these suggestions, for if larval competition increases with increasing larval populations and at the same time increases the larval mortality, any factor tending to reduce early larval populations, such as the colonisation of egg parasites, would result in a smaller mortality of larvae and the controlling effect of the method might be considerably below expectation.

At the present stage, no opinion can be expressed on this question, which requires detailed field studies of the habits of young larvae for its solution (c.f. Tucker, 16, p. 46).

4. Summary.

(1) The influence of non-parasitic mortality is discussed in its relation to biological control. It is shown that, contrary to published opinions, there is no *prima facie* reason to believe that high non-parasitic mortality will affect the success of mass-liberated parasites.

(2) An account is given of breeding experiments designed to elucidate the details of the life history of three species of *Diatraea* affecting sugar-cane in Trinidad. The bearing of the length of the life history on experimental procedure to determine the extent of larval mortality is shown.

(3) Details are given of an experiment designed to estimate the mortality of *Diatraea* larvae in Trinidad.

(4) The mean larval mortality of *Diatraea* in a period of eight months was found to be 81.75 per cent. The maximum possible mortality for one year under the conditions of the experiment is estimated at 87.84 per cent.

(5) The numerical values obtained are compared with similar results found in other West Indian colonies, and possible explanations of the differences are offered.

(6) A correlation is believed to exist between the extent of the larval mortality and the number of eggs laid, but the significance of this is not yet elucidated.

References.

1. Box, H. E., 1932.—Studies on the early larval mortality of *Diatraea saccharalis* in Antigua. *Int. Soc. Sugar-cane Tech.*, 4th Congress, Puerto Rico. *Supp. to Bull.* 122.
2. Box, H. E., 1933.—Report upon the introduction and establishment of the Cuban parasite, *Lixophaga diatraeae* Townsend. Sugar-cane moth borer investigations, Antigua. Colonial Development Fund. (Printed Barbados).
3. Chapman, R. N., 1927.—Animal Ecology. Second (mimeographed) edition, Minneapolis.
4. Fisher, R. A., 1930.—Statistical Methods for Research Workers. London.
5. Myers, J. G., 1929.—Sugar-cane moth borers. *Tropical Agriculture*, Vol. VI.
6. Myers, J. G., 1931.—Preliminary report on the biological control of West Indian insect pests. *E.M.B.* 42. London, H.M. Stationery Office.
7. Myers, J. G., 1935.—Second Report on an investigation into the biological control of West Indian insect pests. *Bull. Ent. Res.*, Vol. XXVI.
8. Pickles, A., 1933.—Entomological contributions to the study of the sugar-cane froghopper. I. Study of biotic factors of control. *Tropical Agriculture*, Vol. X.
9. Robinson, C. K., 1932.—Progress Report for March, 1932. *Min. and Proc. Sugar-cane Inv. Comm.*, Vol. IV.
10. Thompson, W. R., 1927.—On the effect of methods of mechanical control on the progress of introduced parasites of insect pests.—*Bull. Ent. Res.*, Vol. XVIII.
11. Thompson, W. R., 1928.—A contribution to the study of biological control and parasite introduction in continental areas. *Parasitology*, Vol. XX.
12. Tucker, R. W. E., 1930.—The measure of moth borer control. *Dept. Sci. and Agric. Barbados, Pamphlet*, No. 6.
13. Tucker, R. W. E., 1930.—Sugar-cane borers. *Tropical Agriculture*, Vol. VII.
14. Tucker, R. W. E., 1933.—Rate of egg deposition of *Diatraea saccharalis* and extent of larval mortality in cane fi lds and their relation to control of *Diatraea* by *Trichogramma minutum*. *Agric. J. Barbados*, Vol. II.
15. Tucker, R. W. E., 1934.—A contribution towards the solution of the problem of control of *Diatraea saccharalis*. *Agric. J. Barbados*, Vol. III.
16. Tucker, R. W. E., 1935.—Control of *Diatraea saccharalis* in sugar-cane in Barbados. *Agric. J. Barbados*, Vol. IV.

COTTON NOTES.

By S. C. Harland, D.Sc. (Lond.).

In a recent paper, Davie (Chromosome Studies in the Malvaceae and certain related families II, *Genetica*, 17 : 487-498) discusses at some length the origin of the group of New World tetraploid cottons. He rejects the theory put forward by Skovsted (1) on cytological grounds, and strengthened by the writer (2), on genetical evidence, that the New World cottons are amphidiploids derived from two primitive diploid (13 chromosome) types, one of which was probably allied to the present day diploid Asiatics, and the other to one or other of the diploid New World species. He finds it improbable that an Asiatic genom should be present in the New World cottons and considers it more likely that the New World cottons arose from a cross between a wild American diploid and *G. mexicanum* or *brasiliense*. He points out that the Asiatic species *G. arboreum* and *G. herbaceum* were not introduced into America until after the time of Columbus. It is fairly clear that only unfamiliarity with the genetics and cytology of *G. mexicanum* and *G. brasiliense* and with the taxonomic affinities of these species, can have led him to make this suggestion. The writer has examined specimens of *mexicanum* from Central America, and it appears to be a species closely allied to *hirsutum*. The genetics of *brasiliense* has been studied in great detail for the past ten years and it is undoubtedly so closely related to *barbadense* as to be worthy only of sub-specific rank. It is hard to see how crosses between undoubted typical New World tetraploids and wild diploids could have played any part in the origin of the New World types. The suggestion of Davie, though interesting, must therefore be rejected as incompatible with existing knowledge.

The sporadic introductions of Asiatic species which must have been made in the 16th and 17th centuries would appear to have no bearing on the question under discussion, for even the average semi-wild tree cottons (*brasiliense, barbadense* and *purpurascens*) of Central and South America have lint so superior to that of ordinary Asiatic cottons that the cultivation of the latter even if begun, would soon have been abandoned.

The statement is made that "the most important Asiatic (? hybrid) form derived from that species (*G. arboreum* var. *neglecta*) was early carried to America and the West Indies by the East India Company, and is known in the United States to-day under the name of "Okra" cotton. This statement is of course quite wrong. "Okra" cotton is merely a form of *G. hirsutum* (Upland cotton) with laciniated leaves. What is known of the genetics of "Okra" cotton has been summarised in a paper (3) cited by Davie, but apparently overlooked by him.

Regarding the mode of origin of the New World cottons, the recent suggestion of the writer (4) that they arose in late Cretaceous or early Tertiary times in some part of a Polynesian land bridge connecting America with Asia would appear to merit serious consideration since all the genetical and cytological evidence available are in its favour.

References.

1. Skovsted, A.—*J. Genet.*, 28, 407.
2. Harland, S. C.—*J. Genet.*, 30, 465.
3. Harland, S. C.—*Bibliog. Genet.*, 9, 107.
4. Harland, S. C.—*J. Genet.*, 30, 465.

TRINIDAD MAMMALS.

By Desmond Vesey-FitzGerald.

Some forty years ago three important papers were published on the Trinidad Mammals by Oldfield Thomas (1892), and Allen and Chapman (1893 and 1897), but since that time only scattered and more or less inaccessible reference has been made to the subject. Whether due to agricultural development, depredation of the introduced mongoose, or simply due to lack of sufficient interest, it is certain that several species have not been seen or heard of during recent years. Others of extreme interest are certainly becoming very rare, and for their protection legislation has been passed, though since so little is recorded concerning their habits it is possible that the best means of saving these remnants has been overlooked. With these ideas in view, though no extensive collecting has been undertaken by the author, it seemed worth while to put on record various notes and observations obtained from a variety of sources. It would not however have been worth while writing this paper but for the valuable additions of Mr. F. W. Urich and Dr. H. G. Kugler, who have both made observations extending over a considerable period. The most sincere thanks are also due to Mr. M. A. C. Hinton and Mr. R. W. Hayman of the British Museum who very kindly looked over the small collection brought to England, and also offered many helpful suggestions, corrected the nomenclature, and drew attention to specimens already in the British Museum collection and to several important references which had been overlooked.

Acknowledgment is made to the notes by these gentlemen throughout by their initials.

A list of Trinidad bats compiled by Mr. F. W. Urich is included without notes.

The list of references at the end, though not purporting to be complete, includes a number of works which may be of use in determining Trinidad Mammals, or in throwing some light on their habits or distribution.

PRIMATES.

Family : CEBIDAE. MONKEYS.

1. Cebus apella L. "Weeping Capuchin".

Troops commonly seen in the neighbourhood of the Trinity Hills, no records from other parts.

Guayaguayare, on several occasions (H.G.K.); N. slopes of Trinity Hills, 26.xii.31.

2. Alouatta insulanus Elliot. "Red Howler". *Ann. and Mag. Nat. Hist.*, Ser. 8, Vol. V, 1910, p. 79.

The type specimen of this species in the British Museum, collected by H. Caracciolo, differs from *seniculus* and *macconneli* of the mainland by its smaller size and practically uniform colouration (R.W.H.).

Troops commonly seen in virgin forest throughout the island, though still killed by a few native hunters for food. The loud roar of the males is especially noticeable before rain and in the early morning. A female killed at Moruga was carrying one young (H.G.K.)

Guayaguayare, T.L.L. Camp, 22.xii.35; this party of about five individuals may be seen sunning themselves nearly every morning from the Company's Office; Erin Forest Reserve, 24.i.35; Mt. Harris, 3.ix.33; heights above Maracas Bay, 1.x.33.

CHIROPTERA. BATS.

Family : EMBALLONURIDAE.

3. **Rhynchiscus naso** Wied.
4. **Saccopteryx bilineata** Tomm.
5. **Saccopteryx leptura** Schreber.
6. **Peropteryx trinitatis** Miller.
7. **Diclidurus albus** Wied.

Family : NOCTILIONIDAE.

8. **Noctilio leporinus** L.

Family : PHYLLOSTOMIDAE.

9. **Mormops megalophyllum** Peters.
10. **Chilonycteris rubignosa** Wagn.
11. **Pteronotus davyi** Gray.
12. **Phyllostoma hastatum** Pallas.
13. **Phyllostoma discolor** Wagn.
14. **Vampyrus spectrum** L.
15. **Micronycteris megalotis** Gray.
16. **Lonchorhina aurita** Tomes.
17. **Glossophaga soricina** Pallas.
18. **Anoura geoffroyi** Pallas.
19. **Choeronycteris intermedius** Chap.
20. **Hemiderma brevicauda** Wied.
21. **Sturnira lilium** Geoff.
22. **Chiroderma villosa** Peters.
23. **Artibeus planirostris trinitatis** K. And.
24. **Artibeus jamaicensis palmarum** Allen and Chap.
25. **Artibeus quadrivittatus** Peters.
26. **Uroderma bilobatum** Peters.
27. **Enchisthenes harti** Thos.
28. **Vampyrodes caraccioli** Thos.

Family : DESMODONTIDAE.

29. **Desmodus rufus** Wied.

Family : NATALIDAE.

30. **Natalus stramineus** Gray.

Family : FURIPTERIDAE.

31. **Furipterus horrens** F. Cuv.

Family : THYROPTERIDAE.

32. **Thyroptera tricolor** Spix.

Family : VESPERTILIONIDAE.

33. **Myotis nigricans** Wied.
34. **Dasypterus ega** Wied.

Family : MOLOSSIDAE.

35. **Molossus rufus** Wied.
36. **Molossus obscurus** Geoff.

RODENTIA.

Family : SCIURIDAE. SQUIRRELS.

37. Sciurus aestuans hoffmanni (Peters).
"SQUIRREL".

Having diurnal habits the squirrel is frequently seen, and further, being very destructive to cacao, it is well known ; it is a usual practice to pay a bounty of six cents for each tail.

This animal is too common in the cacao and coconut plantations and is also frequent in forest.

Family : MURIDAE. RATS AND MICE.

38. Nectomys palmipes (Allen and Chapman).
"WATER RAT".
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, 1893.
Holochilus squamipes Brants, in Thomas' list (1892), is probably this animal (R.W.H.).

Frequents stream sides.

St. Michael's Valley, N. Range, 26.ii.33 (Det. Hinton, B.M.). Caught in trap by stream through cacao plantation. Female, carrying three embryos, head and body 18.5 cm., tail 17 cm., hind foot 4.5 cm., ear 1.9 cm.

39. Oryzomys speciosus (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xii, 1893.

Two specimens collected by H. G. K. in 1934, (Det. Dr. S. Schaub).

40. Oryzomys delicatus (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.

Found in the cast of a Barn Owl collected at St. Augustine in 1934. Determined by Dr. S. Schaub.

41. Oryzomys trinitatis (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xii, 1893.

No recent record.

42. Oryzomys velutinus (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, 1893.

Spring Hill Estate, Arima, 28.v.33 (Det. Hinton, B.M.), female, head and body 5 in., tail 4 7-8 in., hind foot 1 in., ear ¾ in.

43. Oryzomys brevicauda (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, 1893.

No recent record but there are specimens in the British Museum collected by H. Caracciolo in 1895 (R.W.H.).

44. Rhipidomys couesi (Allen and Chapman).
= *Tylomys couesi* Allen and Chapman. *Bull. Amer. Mus. Nat. Hist.*, Vol. V, Art. xiii, 1893 and Vol. IX, 1897.

An arboreal rat common on certain cacao estates where they do considerable damage to the crops.

Marper Estate, 1931 (Det. Hinton) ; Spring Hill Estate, Arima, 28.v.35, female trapped in cacao tree, head and body 7 in., tail 9 7-8 in., hind foot 1 5-16 in., ear 7-8 in.

There are specimens in the British Museum, collected by Dr. Rendall in 1897 at Curucaye (R.W.H.).

45. Akodon frustrator (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.

No record since original discovery.

46. Akodon urichi (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.

Originally referred by Allen and Chapman (1893) to the species *Abrothrix caliginosus* (Tomes), which does not however occur in Trinidad.

Two specimens taken alive at Maracas, 25.ix.35, were naturally tame and thrived well in captivity. There are specimens in the British Museum collection taken at Savannah Grande and San Juan by Dr. P. Rendall, 1897, and from Maqueripe bay, N. Trinidad, by F. Birch in 1905 (R.W.H.).

Imported Rats and Mice.

47. Rattus rattus L. is the commonest domestic rat in Trinidad—the "Black Rat". This species was very abundant in a house and around stock pens in Maracas Valley (1935), and specimens were also taken in an uninhabited shed in a cacao plantation in Maracas Valley, 8.vii.35 ; in an East Indian house at Tacarigua, 9.ix.35 ; in houses in Port-of-Spain, 14.ix.35 ; and in a coconut plantation at Mayaro, 8.iv.33. At Blanchisseuse and Filette, 9.ix.18, rats were more abundant than usual, forty-three being killed in one room, and considerable damage being done to coconuts in the jelly-nut stage (F.W.U.).

Skulls of this rat were common in casts of the Barn Owl collected at St. Augustine in 1934. Determined by Dr. S. Schaub.

Mr. M. A. C. Hinton writes regarding the numerous forms of this species :—"In my opinion the sub-species of *R. rattus* cannot be determined satisfactorily away from their Indo-Malayan home", and with reference to Trinidad specimens he states that while one specimen in D. V-FG's collection would be regarded as an almost typical *alexandrinus*, others, with white bellies, approach the Mediterranean race *frugivorus*. He sums up by saying : "the only safe thing to do is to refer all to *R. rattus* and leave sub-species alone".

Only a single example of the "Brown Rat" **48. Rattus norvegicus** Berkenhout was collected, and this came from a house in Port-of-Spain, 8.x.35 ; **49. Mus musculus.** The house mouse, would appear to be abundant in houses throughout the colony.

Family : HETEROMYIDAE.

50. Heteromys anomalus (Thompson). "POUCHED RAT".
Trans. Linn. Soc. Lond., XI, 1815.
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, 1893.

Probably a fairly common rat.

Aripo, N. Range, 15.v.32, plentiful in limestone caves feeding on various seeds regurgitated by the guacharo birds (*Steatornis*). Male collected, determined by Hinton, B.M.

Family : OCTODONTIDAE.

51. Echimys armatus Geoff. "SPINY RAT", "PILORI", "PORCUPINE RAT". = *Loncheres castaneus* (Allen and Chapman) = *L. guianae* (Thomas).

Loncheres was replaced by *Echimys* (F. Cuv.) (*see* Thomas, 1916), and *L. guianae* Thos. (*see* Thomas, 1888) was later identified by Thomas as the same animal as *Echimys armatus* Geoff. (R.W.H.).

Comparing this species with the next, Mr. R. W. Hayman says: "this animal is about the same size but it is wholly dull drab brown, flecked on spines which extend from nape to rump with light buff, and the whole underside is clear buff. The ears are shorter, 15 to 18 mm.; as are also the hind feet, 36 to 38 mm."

There are specimens in the British Museum from Caroni River, and from Tobago, collected by Dr. Rendall in 1897. The species is also found on the mainland (R.W.H.). Urich (1911) gives a short note on this species.

52. Proechimys trinitatis (Allen and Chapman). "LONGTAILED PILORI".

Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, 1893.

Mr. R. W. Hayman writes: "This species is rich rufous above, tending to blackish in dorsal line, and is pure white below. Spiny only in centre of back. The ears are longer than those of the last species, 23 to 27 mm.; as are also the hind feet, 40 to 50 mm."

Specimens in British Museum collected by Dr. Rendall at Curucaye in 1897. Also found in Venezuela (R.W.H.).

Family: DASYPROCTIDAE.

53. Dasyprocta aguti L. "AGOUTI".

Though extensively hunted for both sport and food the agouti is still abundant throughout forest and second growth areas. It was found to be especially common in the forest belt between Guayaguayare and Moruga (H.G.K.), and in the forests of the Nariva Swamp.

Diurnal in habits this animal is frequently seen feeding under trees shedding fruit, such as the "Pois-doux" (*Ingna* sp.), "Chenet" (*Melicocca bijuga*), "Crappo" (*Carapa guianensis*) and "Balata" (*Mimusops balata*). Maracas Valley, 1.viii.35, female shot, carrying two embryos.

54. Coelogenys paca L. "LAPPE".

The excellent quality of the meat of this species has created a ready market for its sale and it is to be feared that the Lappe is suffering in consequence. Between November, 1913 and June, 1914 Lappe were commonly observed in the area north of the Trinity Hills as far as Lizard Springs, but when this area was revisited between 1921 and 1935 they were found to have become very rare (H.G.K.) Though still well established in many low-lying forest districts and though nominally protected from 1st January to 30th September, this animal is certainly threatened with extermination in the near future.

Family: CERCOLABIDAE.

55. Synetheres prehensilis L. "PORCUPINE".

Frequently caught by hunters, the flesh being edible, in the plantation and second growth areas of the Northern Range. Two were caught in the Maracas Valley, 24.ix.35. Also common in the mixed rain-forest of the Mayaro, Guayaguayare and Moruga districts (H.G.K.).

CARNIVORA.

Family: FELIDAE.

56. Leopardus pardalis L. "TIGER CAT", "CHAT TIGRE".

Skins are frequently brought in by hunters from the forest belt between Mayaro and Moruga (H.G.K.), and from the forests of the Northern Range.

Maracas Valley, 4.vii.35, female head and body 74 cm., tail 32 cm., fore-leg (elbow to toe) 24.5 cm., weight (dead) 24 lbs. Nursing two kittens, male and female.

Family: HERPESTIDAE.

57. Herpestes mungo Gmelin. "MONGOOSE".

Introduced in 1870 to control rats, but has since become a pest; *see* Urich (1914), Anon. (1918), Myers and Urich (1931).

The large constricting snakes, *Boa hortulana* and *Constrictor constrictor*, have been found to eat mongooses (F.W.U.).

Family: PROCYONIDAE.

58. Euprocyon cancrivorus (Cuv.). "RACOON", "MANGROVE DOG".

This species is common in the coastal mangrove swamps, in the Oropouche Lagoon (H.G.K.), but it also penetrates far up into the mountain forests, probably following the streams for crabs. Also eats ripe fruit.

St. Michael's Valley, Northern Range, 21.iii.35, female shot feeding in Caimite tree (*Chrysophyllum cainito*); Maracas Valley, 17.ix.35, 1,500 feet, specimen caught in trap.

Family: MUSTELIDAE.

59. Tayra barbara trinitatis Thos. "HIGH WOODS DOG".

Ann. Mag. Nat. Hist. Ser. 7, Vol. V, 1900, p. 148.

The type of the Trinidad sub-species, which is in the British Museum, was collected by H. Caracciolo. It differs chiefly from the mainland form by its smaller size (R.H.W.). Frequent in forest areas, being observed several times at Guayaguayare (H.G.K.); Nariva Swamp; Maracas Valley, 20.x.35; and also in plantations, one being seen high up in a coconut tree at Guayaguayare. Said to hunt in small parties.

60. Lutra enudris (F. Cuv.). "WATER DOG", "OTTER". = *L. insularis* (F. Cuv.), *see* Thomas (1908), (R.W.H.).

Though plentiful in the Northern Oropouche River in 1895 (F.W.U.), the otter is now rarely heard of in the northern part of the island, the only recent record being one killed at Guaico early in 1935. In the south it is more frequent, being fairly common in the Moruga River between 1921 and 1925, and being reported from the Mahaut River and Grande Lagoon in May, 1935 (H.G.K.).

SIRENIA.

Family : MANATIDAE.

61. Manatus manatus L. "MANATEE", "LAMANTIN".

"= *Trichechus manatus* L, which is the earliest name for the Manatee but as it was used by everybody for more than 100 years for the walrus, European zoologists have agreed to suppress it to avoid a most confusing transfer. *Manatus* is the name used for the Manatee; *Odobaenus* for the "Walrus". (M.A.C.H.).

Confined to the estuaries of the larger East Coast rivers, a specimen being killed in the Nariva River early in 1935. Mr. C. Swabey reports having seen signs of Manatee feeding in the Northern Oropouche River when he visited it early in 1935.

UNGULATA.

Family : DICOTYLIDAE.

62. Dicotyles tajacu L. "PECCARY", "QUENK", "WILD HOG".

Still frequents the larger and more remote forest areas, though their range has been considerably reduced during recent years.

Especially abundant in the neighbourhood of mud volcanoes, a party of ten being seen in 1914 at Moruga Bouffe, also at Lagoon Bouffe and Lizard Springs, all of which places possess springs of salty water (H.G.K.).

Family : CERVIDAE.

63. Mazama rufa (F. Cuv.) "DEER", "BICHE".

Though extensively hunted the deer is still abundant in forests and plantations. Observations on captive specimens indicate that one fawn is born at a time. This deer is a 'browser' rather than a 'grazer', seeking out a variety of plants, especial favourites with tame specimens being leaves of *Cecropia peltata*, *Hibiscus* (cultivated vars.), *Commelyna* sp., and sweet potato vine, *Ipomoea batatas*. Fallen fruit is also eaten.

EDENTATA.

Family : MYRMECOPHAGIDAE.

64. Tamandua longicauda Wagner. "YELLOW TAMANDUA", "ANTEATER", "MATAPERRO".

T. tetradactyla has for long stood on the Trinidad list and it was only when an incomplete specimen was sent to the British Museum in 1934 that it was realised that this was an error. *T. longicauda*, which was originally described from Guiana, is tolerably common in forest areas at all elevations, a specimen having been seen near the summit of Tucuche, 3,000 feet. *T. tetradactyla* does not occur in the island.

Maracas Valley, 15.vi.35, female, head and body 59 cm., tail (imperfect) 43 cm., hind foot 11 cm., snout to ear 14 cm., ear 7 cm., weight (dead) 9 lb. 7 oz.; Maracas Valley, 1.x.35; Las Cuevas Road, 5.x.35; Maraval, male, head and body 64 cm., tail 48 cm., snout to ear 12 cm., length of tongue 20 cm. (F.W.U.); Mayaro-Guayaguayare-Moruga, seen on various occasions (H.G.K.). A female was killed carrying a single embryo, 10.iv.34 (F.W.U.).

65. Cyclopes didactylus L. "SILKY ANTEATER", "SLOTH", "POOR-ME-ONE".

Common especially in the Central Range. Several killed at Sangre Grande in 1922 were found to have fed on coccinellid beetles (H.G.K.).

Family : DASYPODIDAE.

66. Tatusia novemcincta L. "ARMADILLO", "TATU".

Widely distributed. Common on summit of Tucuche, 3,000 feet; Oropouche basin, E. coast, 15.ix.35; Central Range and Southern Range, burrowing mainly in areas of fine sandy soil (H.G.K.).

The Tatu is regularly hunted with dogs on moonlight nights.

MARSUPIALIA.

Family : DIDELPHIDAE.

67. Didelphis marsupialis insularis Allen. "OPOSSUM", "MANICOU".

Two immature specimens collected in the Northern Range, iv.32 and v.32, determined by Hinton, British Museum. Common throughout the island, in plantations as well as the high forests of Guayaguayare (H.G.K.). Breeding appears to go on throughout the year; females have been taken with young in their pouch, varying from 4 to 7, in the months of March, May and August.

The Manicou is mainly frugivorous, feeding on Avocado (*Persea gratissima*), Orange (*Citrus aurantifolium*), Portugal orange (*C. nobilis*), Pomerac (*Eugenia* sp.), Mango (*Mangifera indica*), and Star Apple (*Chrysophyllum cainito*). Traces of insects were however found in four stomachs examined.

68. Philander trinitatis (Thomas). "MANICOU GROS-YEUX".

Ann. Mag. Nat. Hist. Ser. 6, Vol. XIII, 1894.

Specimen determined by Hinton, British Museum, 1.v.35. The commonest of the small opossums throughout the plantations of the western end of the Northern Range. Breeding appears to take place chiefly during the dry season.

Maracas Valley, 29.iv.35, female, carrying four young, 2 male and 2 female; Maracas Valley, 1.v.35, female, carrying young which she ate when captured; Maracas Valley, 29.vi.35, female, carrying six young, 5 male and 1 female, probably about two months old.

Though eating fruit, being especially fond of Portugal oranges, this species is largely insectivorous, being very partial to all varieties of large insects which it is extremely dextrous at catching.

69. Marmosa chapmani (Allen).

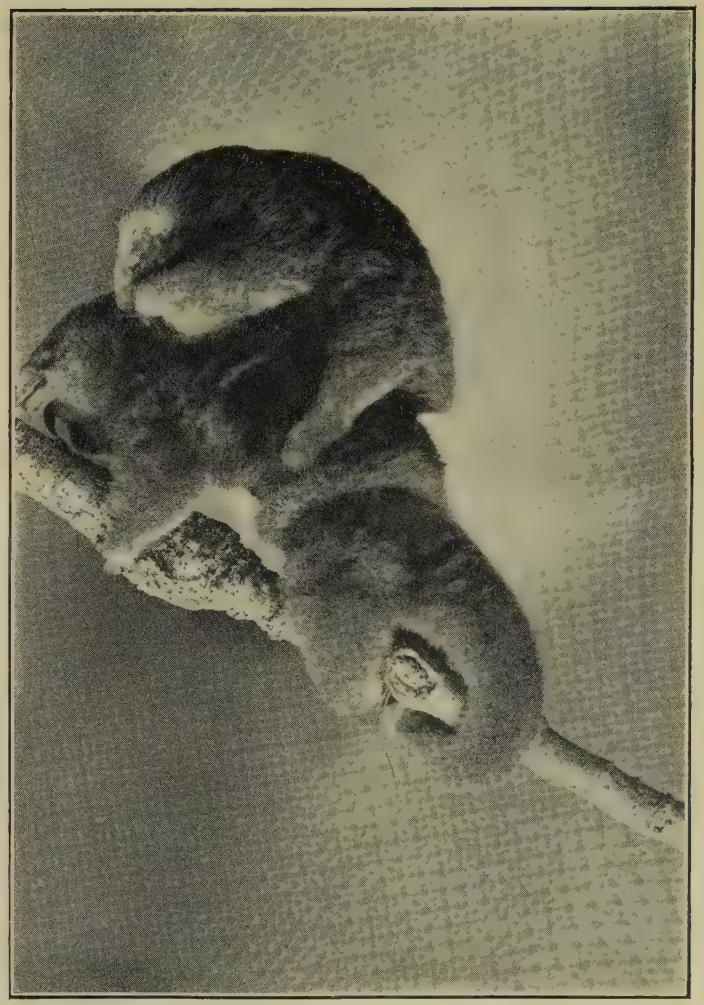
Aripo Valley, 16.ii.35, determined by Hinton, British Museum. Two specimens, one half grown, were collected by Mr. H. Bruins-Lich in the Botanic Gardens, Port-of-Spain, early in 1935.

Chiefly insectivorous, being especially fond of large hawk-moths, but also eats fruit.

70. Marmosa carri (Allen and Chapman).
= *Thylamys carri* (Allen and Chapman).
Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.

Young specimen taken in Maracas Valley, 13.ix.35, determined by R. W. Hayman, British Museum.

ANTEATER (*Tamandua longicauda* WAGNER). IN DEFENSIVE POSITION.



SILKY ANTEATER (*Cyclopes didactylus* L.) FEMALE AND YOUNG.

Literature.

Allen, J. A. and Chapman, F. M.
On a collection of mammals from the island of Trinidad, with descriptions of new species.
Bull. Amer. Mus. Nat. Hist., Vol. V, Art. xiii, pp. 203-234, 1893.

Allen, J. A. and Chapman, F. M.
On a second collection of mammals from the island of Trinidad with descriptions of new species and a note on some mammals from the island of Dominica, B.W.I.
Bull. Amer. Mus. Nat. Hist., Vol. IX, 1897.

Anon.
Mongoose, correspondence regarding.
Proc. Agric. Soc. Trinidad and Tobago, Vol. XVIII, 1918.

Carr, A. B.
A Quenk hunt.
Jour. Trin. Field Nat. Club, Vol. I, No. 11, pp. 269-273, 1893.

Collens, J. H.
The Trinidad Manatee.
Journ. Trin. Field Nat. Club, Vol. I, No. 7, 1892.

De Verteuil.
Trinidad, 2nd Edition, p. 360, 1884.

Elliot.
Ann. Mag. Nat. Hist. Ser. 8, Vol. V, 1910.

Hayman, R. W.
A key to the bats of Trinidad.
Proc. Agric. Soc. Trinidad and Tobago, Vol. XXXII, No. 9. 1932.

Hinton, M. A. C.
Rats and mice as enemies of mankind.
Brit. Mus. Econ. Series No. 8, 1931.

Ledru.
Voyage à Ténériffe et à la Trinité, I, p. 256, 1810.

Myers, J. G. and Urich, F. W.
The Mongoose.
Tropical Agriculture, Vol. VIII, No. 4, 1931.

Mole, R. R.
Notes on a Racoon.
Jour. Trin. Field Nat. Club, Vol. I, No. 8, pp. 184-187, 1893.

Oldfield, Thomas.
A preliminary list of the mammals of Trinidad.
Jour. Trin. Field. Nat. Club, Vol. I, No. 7, pp. 158-168, 1892.
Ann. Mag. Nat. Hist. Ser. 6, Vol. II, 1888.
On two new neotropical mammals.
Ann. Mag. Nat. Hist. Ser. 6, Vol. XIII, pp. 436-439, 1894.
Ann. Mag. Nat. Hist. Ser. 7, Vol. V, 1900.
Ann. Mag. Nat. Hist. Ser. 8, Vol. I, 1908.
Ann. Mag. Nat. Hist. Ser. 8, Vol. XVIII, 1916.

Thompson.
Trans. Linn. Soc. Lond., XI, p. 161, pl. x, 1815.

Urich, F. W.
The Mongoose in Trinidad and methods of destroying it.
Board of Agriculture, Trinidad and Tobago, *Circular* No. 12, 1914.

Urich, F. W.
Proc. Agric. Soc. Trinidad and Tobago, Vol. XXIII, 1923.

Urich, F. W.
Rats and other mammals on cocoa estates.
Board of Agriculture. Trinidad and Tobago, *Circular* No. 3, 1911.

MISCELLANEOUS NOTES.

A Uniformity Trial with Coconuts. *A. W. R. Joachim.*

The data of a uniformity trial carried out at Wariyapola, Ceylon, in 1929-30, on a 360 tree block of coconuts over a period of a year were statistically examined by the method of analysis of variance. The experiment was originally intended to supply information as to the optimum plot size for field experiments with coconuts on the soil type of the station. The results, however, were not analysed at the time owing to the establishment of the Coconut Research Scheme. Now that the officers of the Scheme have been able to analyse statistically yield data from Lunuwila over a period of two years it was thought to be of interest to examine the Wariyapola data, obtained on a lighter soil and under somewhat different climatic and crop conditions in order to see whether the optimum type of plot size would vary. It was found that in both districts with their different climatic and markedly heterogenous soil conditions an 18-20 tree plot is the optimum for field experiments. The randomized block layout was used, and though the actual errors (45 per cent. coefficient of variation) are high compared with temperate crops, the marked variation in yield of individual coconut palms under estate conditions must be taken into consideration. A very similar range of error was obtained by the Coconut Research Scheme at Lunuwila, although the average yields secured were about twice those at Wariyapola. The standard error for an 18 tree plot is about 14 per cent. Six replications are required for treatment differences to be considered significant.—(*Horticultural Abstracts*, Abstract No. 720, Vol. V, No. 4, 1935.)

* * *

Asparagus Cultivation.

A short note by Mr. A. N. Rawes (*J. Roy. Hort. Soc.*, Oct., 1935) gives some very useful information about the cropping of asparagus. Several series of beds containing all male plants were compared with beds planted with female crowns. The result showed that in every case the male plants yielded about 60 per cent. more saleable stems than the females. The series covered a variety of planting methods and differing cultivation, but the superiority of the males was obvious in every case. Very little difference in the relative grades of produce was, however, demonstrable between the two sexes. The paper reports a continuation of previous experiments made at the Wisley gardens, with confirmation of the earlier results, and also discusses the merits of close and wide planting.—(*Nature*, Vol. CXXXVI, No. 3450, p. 958, 1935.)

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

New Method of washing Sugar in the Centrifugals. *W. C. Roos.*

It is explained by the author (and in fact it is generally accepted) that in the ordinary method of washing sugar in a centrifugal machine the water is sprayed upon the inner surface only, so that in order to reach the outer layers more water is required than suffices to wash this inner layer, the result being some solution of crystal.

In order to overcome this difficulty, it is now proposed to wash the charge of sugar in layers, using a system of channels for conveying the water to different points. Hence, after the green syrup of the charge has been spun off, a little water is successively applied to the first layer, then to the second, and so on to a third, or even a fourth layer, the whole of the depth of sugar thus being cleared up with a minimum of water.

A device for carrying this idea into effect has been tried out in a machine build by a well-known firm of centrifugal constructors in Germany; and (according to the author's statement) the invention has given a satisfactory result. Some figures are given below in evidence of this claim. In Test A the water was applied in the usual way to the inner surface of the layer of sugar; in Test B only 10 per cent. of the water was so applied, the rest being passed through the layer washing device; while in Test C only about half this quantity of water was applied to the charge of sugar, and this entirely through the new washing device.

	Test A.	Test B.	Test C.
Weight of the massecuite, grms. ...	5,615	5,625	5,615
Weight of the green run-off, grms. ...	2,505	2,475	2,515
Purity of the green run-off, grms. ...	77.0	77.0	77.4
Weight of sugar before covering, grms. ...	3,110	3,150	3,100
Weight of sugar after covering, grms. ...	2,320	2,350	2,650
Difference=sugar dissolved, grms. ...	790	800	450
Weight of covering water, grms. ...	810	810	404
Temperatures of the covering water, °C.	18.5	18.5	21.0
Purity of the second or white run-off, °C.	93.9	92.0	89.3
Rendement, per cent. massecuite ...	41.3	41.6	47.2
Rendement, per cent. sugar in massecuite	68.9	69.4	78.8

Analyses of the Sugars.

	Test A.	Test B.	Test C.
Polarization ...	99.40	99.45	99.15
Moisture, per cent. ...	0.30	0.40	0.69
Ash, per cent. ...	0.13	0.07	0.05
Purity	99.70	99.85	99.84

It is seen that in Test C a higher sugar rendement was obtained and with only half the amount of water, compared with Test A, besides which the purity of the white run-off was distinctly lower. Colour determinations of the three sugars also showed that obtained in Test C to be decidedly whiter than that from Test A. So far as these figures go, therefore, the idea would appear to be an interesting one. In this article the author does not describe details of the device he recommends. It is obvious, however, that the layer washing system might be arranged in different ways.—(*Int. Sugar Journal*, Vol. XXXVIII, No. 448, pp. 148-149, 1936.)

* * *

An Electrical Conductivity Method of examining Lime. *F. Baerts and S. Lange.*

It is known that the rapidity of the slaking of a sample of quick-lime is very variable, depending both on its chemical composition, and on the way in which it has been burnt. Consequently a study of the conductivity of the system, calcium oxide-calcium, hydrate-water in excess, should provide interesting indications on the quality of the material under examinaton. Having determined the cell constant and the conductivity of say 200 c.c. of water, 0.1 grm. of the sample of finely divided quick-lime is added, and conductivity readings taken from min. to min. Then the resistances are plotted against the times, and the curve obtained compared with those obtained with other qualities of lime. Or a 20° Brix solution of sugar could be used in place of water.—(*Inter. Sugar Journal*, Vol. XXXVIII, No. 448, p. 146, 1936.)

* * *

Weed Elimination.

A machine has been developed by the Labour Saving Devices Committee of the Hawaiian Sugar Planters' Association for the elimination of weeds in the cane line*. It is a double revolving brush weeder evolved from a single weeder purchased by Mr. Larsen in Australia in 1930, fitted with brushers from an Elgin street sweeper. It will help to control weeds in the cane line, provided they are caught before reaching a height of two inches.—(*Int. Sugar Jr.*, Vol. XXXVII, No. 439, p. 278, 1935.)

* Proceedings of the 5th Annual Meeting of the H. S. P. A., 1934, p. 7.

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Synthetic Resins for Base Exchange Process of Water Treatment.—*C. H. S. Tupholme.*

Experiments at the Chemical Research Laboratory of the Department of Scientific and Industrial Research have led to the discovery that synthetic resins prepared from certain phenols and tannins possess marked base-exchange properties. Some of these resins are capable of removing as much calcium and magnesium from hard water as an equal weight of the commercial water-softening materials with the highest base-exchange values. Other resins prepared from aromatic bases, such as aniline, possess the property of removing anions or acidic radicals from solution. By passing water through granules of the two classes of resins in separate tubes arranged in series, the salts in solution can be removed. For example, by treating city water first with a tannin resin and then with an aniline resin the solids in solution were reduced from about 33 parts to about 1 part per 100,000. The same process carried out about two or three times removes most of the salt from sea water.

The synthetic resins referred to are prepared by the condensation of certain phenolic substances. Most of these phenols or acidic resins are insoluble in water and in dilute acid and alkaline solutions and they are not readily disintegrated. By the use of selected resins, various cations including aluminium, antimony, arsenic, ammonium, barium, beryllium, bismuth, cadmium, calcium, cobalt, chromium, copper, cerium, ferrous and ferric iron, lead, lithium, magnesium, manganese, mercury nickel, potassium, silver, sodium, strontium, thallium, thorium, tin, titanium, uranium, vanadium, zinc and zirconium can be removed from solutions of their compounds. After use, these acidic resins can be regenerated by treatment with solutions of acids, such as hydrochloric, or of certain salts.

Exchange of cations with some of the phenolic resins appears to be selective in character, whereas with other resins of the same type the exchange is similar to that of base-exchange zeolites used in water-softening. For example, the resin prepared in the presence of hydrochloric acid from catechol and formaldehyde will remove lead from a solution of the acetate but will not remove thallium from solutions of the nitrate.

Many of the resins prepared from natural tannins are equal to commercial base-exchange zeolites in their ability to remove calcium and magnesium from hard water and they can be regenerated with solutions of sodium chloride by the same method as that employed for zeolites; they also remove sodium, calcium, and ammonium, not only from aqueous solutions of salts of these cations, but from solutions of the hydroxides. The results of one series of experiments in which tannin resins were employed to soften city water are given in the following table:

BASE-EXCHANGE VALUES OF TANNIN RESINS FROM EXPERIMENTS WITH CITY WATER.

	Lb. CaO per 100 lb. Resin.
Resin:	
Larch bark extract	0.8
Indian acacia cutch	0.9
Mangrove cutch	1.1
Wattle bark extract	1.1
Gambier	1.3
Quebracho	2.0
Zeolite:	
Mineral, non-porous	0.4
Mineral, porous	0.8
Synthetic	2.0

In this table the exchange values of the resins are given in lb. CaO per 100 lb. of resin; the corresponding values for representative commercial zeolites used for water-softening are included for comparison.

It has also been found that resins prepared from certain aromatic bases, particularly those from aniline and *m*-phenylenediamine, are insoluble in water and possess the property of removing anions from solutions of acids, such as sulfuric, nitric, hydrochloric, and acetic, and from solutions of salts of the acids. It should be emphasised that the experiments so far carried out with synthetic resins are only of a preliminary character. Further investigation is required before any opinion can be given regarding the possibilities of the processes on a large scale and the suitability for drinking purposes of water treated by the resins.—(*Ind. & Eng. Chem., News Ed.*, Vol. 14, No. 1, p. 3, 1936.)

* * *

Green Manuring.

It has been found that by the growth of a winter legume as a green manure, yields of citrus are increased by 33 per cent. In addition the structure of the soil is maintained, thus facilitating tillage operations and the application of irrigation water. The nitrate relationship of the green manure plots are being studied extensively. It has been shown that during the growth of the legume, soil nitrates are depressed, but on ploughing-in the legume there is an immediate increase of nitrates near the surface. In the lower layers the nitrate content of the clean culture plots is greater than that in the green manure plots. Green manures have a big effect on the growth of both trees and cereals, and this appears to be greater than can be explained by the increase in soil nitrates. Interesting effects of green manuring on the ripening of oranges have been noted.—(*Hadar*, Vol. VIII, No. 12, p. 331, 1935.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible, to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observation is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR.—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.)

	Foreign.		*Preferential.*	
	s.	*d.*	*s.*	*d.*
26th March	4	9¾	8	6¾
2nd April	4	11¼	8	8¼
9th April	4	11¼	8	8¼
16th April	5	0	8	9
23rd April	5	0	8	9
30th April	4	10½	8	7½
7th May	4	9¾	8	6¾
14th May	4	9	8	6
(16th *May*, 1935)	5	0¾	8	9¾

The market has been steadier, trade in raw sugar being done at slightly advanced prices. The position generally is quiet with a steady undertone. Current import statistics indicate a fairly heavy volume compared with last year of which Empire sugars are a prominent feature, there being a sharp improvement in receipts from the B.W.I. and British Guiana. World consumption during 1935 is placed by Willet and Gray at 27,276,283 long tons, Raw value, as against 26,205,072 tons in 1934.

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian F.G.F. Sakel.*
27th March	6.44	9.20
3rd April	6.50	9.15
9th April	6.57	9.21
17th April	6.58	9.14
24th April	6.62	9.15
1st May	6.46	—
8th May	6.44	—
15th May	6.47	—
(17th *May*, 1935)	6.90	8.43

The quotations for raw cotton have been rather irregular, demand being moderate in view of the complex American domestic situation. The demand for West Indian Sea Island continues, the sales ranging from 19*d*. to 22*d*. a lb.

* * *

LIME PRODUCTS.—*Lime Oil.*—Handpressed is neglected with sellers at 35*s*. per lb. *ex* wharf. The demand for Distilled is very disappointing with sellers of a limited quantity at 22*s*. 6*d*. *Lime Juice.*—The demand for Concentrated has fallen away again, and at present there is no quotation. Raw is valued nominally at 2*s*. to 2*s*. 6*d*. per gallon for good to fine.—(*West India Committee Circular*, 23rd April.)

COCOA.—The cocoa market at present is quiet after the firmness experienced during the past few weeks. First hand sellers of all descriptions were induced to advance their limits, but so far buyers have not responded, and they seem to be content to look on just now, awaiting developments. The price of Accra has increased in certain directions to 25*s*. c.i.f., with no buyers even at 24*s*. 9*d*. The local market is firm at $9.20 per fanega.—(*By courtesy of the Cocoa Planters' Association of Trinidad, Limited.*)

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows:—

	Pence per lb.
25th March	7 7-16
1st April	7 1-2
8th April	7 7-16
15th April	7 9-16
22nd April	7 9-16
29th April	7 3-8
6th May	7 3-8
13th May	7 5-16
(15th *May*, 1935)	5 7-8

The market has been steady with prices generally unchanged. The statistical position continues slowly to improve but some apprehension has been expressed in market circles concerning the possibility of a relaxation of the quotas by the International Rubber Regulation Committee at its next meeting. A decision to maintain these would probably have a stimulating effect on prices. American consumption for March is placed at 42,703 tons as against 36,746 tons in February.

* * *

BANANAS.—There has been a good demand, Jamaicas advancing to £18 5*s*. per ton delivered London and £18 nearest station Provinces. Brazilians are quoted at £15 delivered nearest station.

* * *

COPRA continues quiet with West Indian f.m.s. 5*s*. per ton lower at £14 c.i.f. London.—(*West India Committee Circular*, 23rd April.)

* * *

COFFEE.—Fine descriptions sold well realising firm prices on short supply. The bulks of the offerings were Costa Ricas, country cleaned selling up to 97*s*. Superior Santos, 36*s*., Kenya, bold, greyish-greenish, 54*s*. to 75*s*., bold fair to good, 65*s*. to 85*s*.; seconds, 51*s*. to 55*s*.